Annual Report of the

Board of Scientific Advice for India

for the year 1910-11

Agents for the Sale of Books

PUBLISHED BY

THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA, CALCUTTA.

IN ENGLAND.

BERNARD QUARITCH, 11, Grafton Street, New Bond Street, London, W.
T. FISHER UNWIN, 1, Adelphi Terrace, London, W.C.
CONSTABLE & Co., 10, Orange Street, Leicester Square, London, W.C.
H. S. KING & Co., 65, Cornhill, and 9, Pall Mall, London.
P. S. KING & SON, 2 & 4, Great Smith Street, Westminster, London, S.W.
GRINDLAY & Co., 54, Parliament Street, London, S.W.
W. THACKER & Co., 2, Creed Lane, London, E.C.
DEIGHTON BELL & Co., Cambridge.
B. H. BLACKWELL, 50 & 51, Broad Street, Oxford.
LUZAC & Co., 46, Great Russell Street, London, W.C.
KEGAN PAUL, TRENCH, TRÜBNER & Co., 68—74, Carter Lane, E.C.

ON THE CONTINENT.

R. FRIEDLÄNDER & SOHN, Berlin W. N., Carlstrasse, 11.
OTTO HARRASSOWITZ, Leipzig, Germany.
MARTINUS NIJHOFF, The Hague, Holland.
ERNEST LEROUX, 28, Rue Bonaparte, Paris.
KARL HIERSEMANN, Leipzig, Germany.

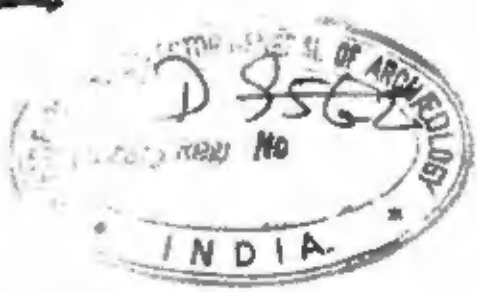
IN INDIA.

THACKER, SPINK & Co., Calcutta and Simla.
NEWMAN & Co., Calcutta.
R. CAMBRAY & Co., Calcutta.
S. K. LAHIRI & Co., Calcutta.
B. BANERJEE & Co., Calcutta.
The Calcutta School Book and Useful Literature Society, 1, Wellington Square, Calcutta.
BUTTERWORTH & Co. (India), *Ltd.*, Calcutta.
THACKER & Co., Ld., Bombay.
A. J. COMBRIDGE & Co., Bombay.
D. B. TARAPOREVALA, SONS & Co., Bombay.
GOPAL NARAYAN & Co., Bombay.
RADHABAI ATMARAM SAGOON, Bombay.
SUNDER PANDURANG, Bombay.
RAM CHANDRA GOVIND & Son, Bombay.
V. KALYANARAMA IYER & Co., Madras.
G. A. NATESAN & Co., Madras.
HIGGINBOTHAM & Co., Madras.
S. MURTHY & Co., Madras.
THOMPSON & Co., Madras.
TEMPLE & Co., Madras.
COMBRIDGE & Co., Madras.
P. R. RAMA IYER & Co., Madras.
N. B. MATHUR, Superintendent, Nazair Kanun Hind Press, Allahabad.
SUPERINTENDENT, AMERICAN BAPTIST MISSION PRESS, Rangoon.
A. CHAND & Co., Lahore.
RAI SAHIB M. GULAB SINGH AND SONS, Mufid-i-Am Press, Lahore and Calcutta.
A. M. & J. FERGUSON, Colombo, Ceylon.
S. C. TALUKDAR, Proprietor, Students & Co., Cooch Behar.

Annual Report of the

Board of Scientific Advice for India

for the year 1910-11



Calcutta
Superintendent Government Printing, India
1912

Price Re. 1 or 1s. 6d.

Members of the Board of Scientific Advice.

Name.	Appointment.
The Hon. Mr. E. D. Maclagan, C.S.I., I.C.S.	Secretary to the Government of India (Department of Revenue and Agriculture) and *ex-officio* President, Board of Scientific Advice.
I. H. Burkill, Esq., M.A., F.L.S.	Economic Botanist, Botanical Survey of India.
G. T. Walker, Esq., C.S.I., M.A., D.Sc., F.R.S.	Director-General of Observatories.
N. Annandale, Esq., D.Sc., B.A., C.M.Z.S.	Superintendent of the Indian Museum.
Colonel S. G. Burrard, C.S.I., R.E., F.R.S.	Surveyor-General of India.
Colonel H. T. Pease, C.I.E., M.R.C.V.S.	Principal, Punjab Veterinary College.
Morris W. Travers, Esq., D.Sc., F.R.S.	Director of the Indian Institute of Science.
F. Beadon-Bryant, Esq., C.S.I.	Inspector-General of Forests to the Government of India.
B. Coventry, Esq. . .	Offg. Inspector-General of Agriculture in India.
H. H. Hayden, Esq., C.I.E., B.A., B.E. (T.C.D.), F.G.S.	Director of the Geological Survey of India.
Major A. T. Gage, I.M.S., M.A., M.B., B.Sc., F.L.S.	Director of the Botanical Survey of India and Secretary, Board of Scientific Advice.

List of Sub-Committees.

Sub-Committee A.—(*Meteorology, Terrestrial Magnetism and cognate subjects.*)

1. The Surveyor-General of India (Chairman);
2. The Director-General of Observatories;
3. The Director, Geological Survey of India.

Sub-Committee B.—(*Agricultural Products*).

1. The Director, Botanical Survey of India (Chairman);
2. The Economic Botanist, Botanical Survey of India;
3. The Inspector-General of Agriculture.

Sub-Committee C.—(*Soils and Manures*).

1. The Inspector-General of Agriculture (Chairman);
2. The Director, Geological Survey of India;
3. The Inspector-General of Forests.

Sub-Committee D.—(*Forest Products*).

1. The Inspector-General of Forests (Chairman);
2. The Economic Botanist, Botanical Survey of India;
3. The Director, Botanical Survey of India.

Sub-Committee E.—(*Veterinary Subjects*).

1. The Inspector-General, Civil Veterinary Department (Chairman);
2. The Inspector-General of Agriculture;
3. The Superintendent of the Indian Museum.

Sub-Committee F.—(*Libraries*).

1. Morris W. Travers, Esq., D.Sc., F.R.S. (Chairman);
2. The Director-General of Observatories;
3. The Economic Botanist, Botanical Survey of India;
4. The Surveyor-General of India;
5. The Director, Geological Survey of India.

CONTENTS.

ANNUAL REPORT FOR 1910-11

ANNUAL REPORT

OF THE

BOARD OF SCIENTIFIC ADVICE FOR INDIA

1910-11

SUMMARY OF PROCEEDINGS.

Twentieth Meeting held at Simla on the 19th May 1911.

The Board considered the reply by Professor Dunstan, the Director of the Imperial Institute, London, to the request of the Board that in addition to the names of external referees consulted by the Director of the Imperial Institute the names of officers of the Imperial Institute could also, when asked for, be furnished in connection with investigations conducted at the Imperial Institute on behalf of India. The Board accepted Professor Dunstan's decision not to furnish the names of officers of the Imperial Institute staff who had conducted investigations on behalf of India, but understood that it was not in accordance with the usual practice elsewhere to withhold the names of subordinate scientific workers and expressed the opinion that to do so would detract from the value of assistance which the Imperial Institute gives to science in India.

The programmes of the various scientific departments for 1911-12 were then considered. The Board resolved to accept them as they stood except that the Director-General of Observatories was at liberty to withhold from the programme certain items with which his reduced staff could not deal.

Twenty-first Meeting held at Calcutta on the 21st December 1911.

The Board considered the general question of the publication in unofficial journals or memoirs of results of investigations in the Departments of Agriculture, Civil Veterinary, Survey of India, Indian Museum—Zoological, Anthropological and Industrial sections—Forestry, Botanical Survey and Geological Survey. The Board recommended that all papers by the officers of those departments intended for publication should in the first instance be submitted to the head of the department concerned, but the Board were of opinion that the existing rules were adequate in this respect.

The draft Annual Report of the Board for 1910-11 was then considered. The Board resolved that contributors to the Annual Report should not necessarily confine their references to investigations the results of which had been published nor to purely departmental work; that the preparation of the report on Veterinary Science for the coming year should be entrusted to Colonel Pease; that subject to modification in several of the sections the report be adopted.

The revised distribution list of the Annual Report of the Board for 1910-11 was read together with new applications for copies. It was resolved that the list as revised be accepted.

APPLIED CHEMISTRY

BY

J. WALTER LEATHER, PH.D., F.I.C., F.C.S.,
Imperial Agricultural Chemist,

D. HOOPER, F.I.C., F.C.S., F.L.S.,
Curator, Industrial Section, Indian Museum,

AND

PURAN SINGH, F.C.S.,
Forest Chemist.

The following is a review of the chemical work done during the year in connection with Indian industries and agriculture, and on Indian material examined in other countries. The matter has been arranged according to the following classification:—

I.—Analytical methods.
II.—Industries based on mineral production.
III.—Chemistry and physics of soils, water and manuring.
IV.—Analyses of organic raw products and manufacturing processes connected with them.

1. Gums, resins and rubber.
2. Fixed and volatile oils.
3. Dyes and dyeing.
4. Tans and tanning.
5. Fibres and paper.
6. Flour, sugars, starch, foods.
7. Accessories to human food.
8. Spirits.
9. Drugs.

I.—Analytical Methods.

Estimation of tannin.—Attempts were made to simplify the process for tannin estimation as adopted by the International Leather Trades Association by finding a suitable substitute of a definite composition for

hide powder. The Forest Chemist is glad to note that he has succeeded in doing so (36). Nickel hydroxide when freshly prepared makes a very good substitute for hide powder. Thirty-seven specimens of different Indian tanning materials such as Mangrove, Acacia, Oaks and Myrobalans were analysed side by side both by the chromed hide powder and freshly prepared nickel hydroxide with results that are in fair agreement with each other. The action of nickel hydroxide was tried on tannin and non-tannin solutions of known strength with the result that the whole of the tannin was precipitated, while such substances as cane sugar and glucose remained in the mother liquor.*

II.—Saltpetre Industry.

Saltpetre.—The refining of saltpetre in India has been the subject of investigation at Pusa. The defects of the present processes as employed in India are as follows:—

(*i*) The time occupied in recovering the refined saltpetre varies from five to ten days before the first product, the "Kalmi shora," and amounts to months before the second or "Kuthia shora" is obtained. Consequently the invested capital is "turned over" only slowly.

(*ii*) The quality of these products, especially the latter, varies, and frequently leaves much to be desired; the "Kalmi shora" varies from about 85 to 95 per cent. of pure potassium nitrate and the "Kuthia shora" from [redacted] to 76 per cent. It is generally more or less brown coloured.

(*iii*) The amount of water which has to be evaporated and consequently the fuel used is larger than should be necessary.

(*iv*) The processes are interfered with partly or wholly by the monsoon.

(*v*) The loss of nitrate entailed in the processes is not a small amount.

A modified process, which includes the use of special appliances, was devised last year with the object of remedying as far as possible the defects just enumerated. In this the crude saltpetre is heated with a limited amount of mother liquor to a temperature near the boiling point, so as to bring the potassium nitrate into solution. The hot liquid mass is then run into a filter which is maintained at a temperature of near 100°C., and the solution of potassium nitrate separated with the aid of

* A paper on the subject has been sent to the Society of Chemical Industry (35), London, for publication. Further work on the subject is in progress.

pressure from the insoluble matters. The hot clear filtrate is next run into coolers in which the nitrate separates as fine grained white crystals and this product is finally separated from the mother liquor by a centrifuge. Having worked well in the laboratory, a larger sized "plant" suitable for the refinement of one maund of crude saltpetre per day, was made in Mozafferpore and worked at the United Provinces Exhibition throughout the three months. It was found that about nine-tenths of the nitrate in the crude saltpetre could be extracted during the day in the form of a nice white refined saltpetre testing about 94 per cent. purity (that is 6 per cent. refraction) and the process was watched with considerable interest by refiners who visited the Exhibition.

A larger "plant" is now being made, capable of dealing with from 20 to 30 maunds of crude saltpetre daily with which the actual cost of working the process can be ascertained, which was not possible with the small exhibition "plant."

A description of the Indian processes and of the newly devised one has been published as a Bulletin of the Imperial Agricultural Department (18).

III.—Soils.

Drainage.—This subject was briefly referred to in last year's report. The records which have been maintained for some years at Cawnpore and at Pusa, have been compiled and examined and are now being published as a memoir (19). The following are the deductions which have been made:—

(i) The amount of drainage and evaporation in India exhibit the same characteristics that have been met with at Rothamsted, namely, the quantity evaporating is nearly independent of the season, whilst the drainage varies with the rainfall. The annual evaporation from fallow land at Pusa is estimated to be about 28" whilst that at Cawnpore is about 18" of water.

(ii) One effect of a crop is to reduce the amount of water *evaporating from the surface soil*, and the Indian records have provided an estimate of this protective effect. A good crop, whilst itself transpiring large amounts of water, will reduce loss of moisture in this manner to two-thirds or one-half of what it would be from exposed fallow land.

(iii) The amount of ammonia present in the drainage water both from bare fallow, as also from cropped land, is as small as

has been found at Rothamsted. The amount of nitrate has been in years of good rainfall much greater than at Rothamsted.

(iv) The amount of nitrate in drainage water from cropped land is very much less than from fallow land, which deficiency is in part due to assimilation by the crop, but there is also some evidence that higher plants interfere with nitrification.

(v) Nitrification has been found at Pusa to be active only during wet weather and then only for a short time.

(vi) The evidence of the Indian records goes to show that the water descending during wet weather passes very uniformly through the soil and not chiefly by means of "large channels" as has been commonly supposed.

Rab.—The *rab* process of heating the earth of paddy seed beds which obtains in most parts of the Bombay Presidency, has been the subject of investigation by Mann, Joshi, and Kanithar (22). They have shown that heating the surface soil is an advantage to the seedling and this forms another instance of an effect which has been demonstrated by a number of European investigators, but they consider it probable that the effect is not wholly due to biological changes and attribute it in part to a physical change. They also directed attention to the use of oil-cake, more especially safflower cake, as a substitute for the *rab* process, and consider it probable that the field experiments at Lanovli will demonstrate the success of this substitution. One question which is very pertinent to this subject, seems to have been left unconsidered, namely, why it is that this *rab* process is met with only in the Deccan, Gujarat and parts of Sind, whilst it is never employed in other parts of India.

IV.—(2) Gums, Resins and Rubbers.

Bombay gum.—The Semul tree (*Bombax malabaricum*) yields in the dry weather a white, opaque, viscous mass which turns red and finally dries into hard, brittle brown tears. This peculiar gum is called "Mocharus." Dr. F. P. Phillips investigated (33) its chemical properties and discovered that it contains a considerable quantity of catechol tannin. On hydrolysis with hydrochloric acid it yields an amorphous, insoluble, crimson substance named "Semul red" and a body reducing Fehling's solution.

Shellac.—Mr. A. C. Langmuir, whose method for the determination of rosin in shellac, based on the iodine absorption under fixed conditions,

has been recommended by the American Chemical Society as a standard, has contributed with Mr. F. S. White (17) a further paper on the analysis of shellac. The authors deal with various methods of iodine absorption when applied to old and fresh samples and they describe shellac-wax and give directions for separating the amount of arsenic added in the form of orpiment or yellow sulphide of arsenic.

IV.—(a) Fixed and Volatile Oils.

Fish oils.—At the instance of the Honorary Director of Fisheries to the Madras Government an enquiry has been made in the Indian Museum as to the nature of the fish oils used in jute batching. It appears that whale or fish oil obtained from Norway, Dundee and Glasgow, mixed with petroleum, is used for this purpose. Samples of the fish oils were found to have a specific gravity ranging from 0·920 to 0·921, acid values from 12·1 to 96·1, and iodine values from 46·1 to 152·1. The acid values are usually high on account of the oxidisable nature of these oils, and the low iodine value points to probable adulteration. The Director of Fisheries, Madras, subsequently sent samples of sardine oil prepared at Cannanore for the purpose of distributing them to the jute mills for an expression of opinion as to their value. The oils possessed a gravity ranging from 0·928 to 0·933, acid values from 4·35 to 37·01, and iodine values from 118·5 to 130·7. The oils proved to be satisfactory when mixed with mineral oil, and provided that they could be supplied at a reasonable rate the local product should meet with a ready demand in the jute mills.

Lemon grass oils.—An interesting account of the distillation of lemon grass oil has been contributed by Mr. W. Reinhart. Lemon grass (*Cymbopogon flexuosus* Stapf) occurs both in the wild state and as a cultivated plant on the western littoral of South India from Cape Comorin northwards to Malabar on the lower spur of the ghâts. The most important districts are the back country of Anjengo, the hilly borders of the Periyar river in Travancore, Peermade in Travancore and Nelliampathies in Cochin. In some few districts as for instance in Wynaad, the low aldehyde content of the oils produced had a discouraging effect upon the production, but the villagers are apparently able to make distilling pay even at as low a price as 2d. per oz. Messrs. Schimmel & Co. have recently shown (42) the constants of the readily soluble East Indian (*e.g.*, Malabar, Cochin or Travancore) lemon grass oil derived from *C. flexuosus* Stapf, and the so-called West India oil,

which is distinguished by its slight solubility, from *C. citratus* Stapf. These may be compared with the oil of two varieties of *C. Nardus*, citronella grass, growing in Ceylon.

	Sp. Gr.	α_D	Citral content.
C. flexuosus	0·916	+ 0°25′	87·5%
C. citratus	0·892	− 0°26′	75%
C. Nardus	0·894 to ·929	+ 12°12′ to 6°32′	Geraniol. 39·1 to 64·7

The lemon grass growing in Jalpaiguri and the Duars, mentioned in last year's report as giving a pleasant smelling oil, has been identified as *C. pendulus* Stapf.

Sandal wood oil.—Mr. W. Reinhart has drawn attention to the preparation of sandal wood oil in Udipi, South Kanara, where it appears to be an ancient industry. Native merchants from Udipi attend the auctions in Mysore and Coorg every year and pay high prices for the wood. The centre of the industry is in the north-east of Karkal up to the foot of the ghâts. The wood is cut into chips and placed in earthenware stills about 2½ feet high and 6½ feet in circumference, water is added and the distillation is continued day and night for a whole month. The oil yield is said to be as follows: Roots about 4·34 per cent., Jugpokalo 3·47 per cent., and Ain Chittas 2·6 per cent. The oil is exported chiefly from Mangalore where it is shipped to Bombay for the Persian Gulf and China. The present value of the oil is about 32 sh. per kilo. Owing to the prolonged duration of the distilling process, decomposition products are formed which must necessarily injuriously affect the quality of the oil. A sample examined by Messrs. Schimmel & Co. (42) had a specific gravity of 0·9898 at 15° and a santalol content of 95·4. The high density, train-like odour and insolubility were unfavourable properties and could not account for the fancy price realised for it.

Oil-yielding qualities of sandal wood.—Fifteen specimens of sandal wood were received from Mr. F. A. Lodge, Conservator of Forests, Madras, for the determination of their oil value, and to find out if the wood of the trees growing in dry rocky mountainous soil is richer in oil than that of the trees found in the more fertile soils of the plains.

Three of the specimens were mostly sap wood showing 0·48 to 0·78 per cent. of essential oil, the others gave from 1·96 to 5 per cent. of oil. It was shown that the wood of the trees growing in rocky soil yielded more oil than that of the trees growing in comparatively fertile soils. The constants of the oil made by mixing the products obtained in the distillations are as follows:—

Specific gravity at 25°C.	·9765
Optical rotation	−15·6° to −16°
Saponification number before acetylation	9·72
Saponification number after acetylation	21·13
Santalol content	99·4

A note on the subject by the Forest Chemist has been prepared in which it is indicated that the industry of the distillation of sandal wood oil in India is full of promise.

Turpentine oil.—The high price of turpentine oil has created a renewed interest in the industrial exploitation of the indigenous *Pinus longifolia*, a tree which is rich in oil. In Kangra several experimental plots have been started in order to learn something of the potentialities of the industry, the best methods and times of tapping, the exact yield of given trees and the effect of repeated tapping on the life of the trees. The oil produced in India is about 50,000 gallons and is consumed locally. There are certain disadvantages in this oil which prevent its successful competition with imported American and European products. The reason for the difficulties in the way of the sale of Himalayan turpentine may perhaps be due to the fact that, as ascertained by Messrs. Schimmel & Co. (42), its composition differs altogether from that of ordinary oil of turpentine, the oil being especially remarkable for its high silvestrene content. For this reason it lacks the valuable oxygen absorbing and drying qualities which are peculiar to pinene. The oil of *Pinus longifolia* in fact possesses some resemblance to pine tar oil.

Cinnamomum glandulifferum.—Mr. R. S. Pearson, of the Forest Research Institute, Dehra Dun, has obtained from the leaves of this laurel tree growing in the lower Himalayas a camphor which must probably be regarded as identical with the Japanese commercial product. A sample sent to Messrs. Schimmel & Co. (42) possessed a melting point of 175°, and a specific rotation in alcohol of +46·32°. When boiled with acetic anhydride no alcoholic constituent, such as borneol, could be detected; the crude product therefore consisted only of d-camphor.

Pinus excelsa *Wall.*—A sample of oil distilled from the cones of the Indian Blue Pine has been examined by Messrs. Schimmel & Co. (42). The oil was of a yellow colour and possessed the following constants: Specific gravity at 15° 0·8757, $^{\cdot}D$ −32°45′, acid value 0·5, ester value 5·6, corresponding to 2·0 per cent. of bornyl acetate, soluble in 5 volumes and more of 90 per cent. of alcohol. Turpentine is rarely extracted from this pine which grows at higher elevations than *Pinus longifolia*.

Xanthoxylum alatum *Roxb.*—The fruit of this tree belonging to the hills of Northern Bengal as well as China is called "Chinese Wild Pepper." Messrs. Schimmel & Co. (42) obtained by distillation 3·7 per cent. of a lemon-yellow oil with a peculiar odour of water-fennel, and 0·9 per cent. of a crystalline substance. The oil appears to consist chiefly of hydrocarbon, the nature of which remains to be investigated, while the odour suggests the presence of phellandrene. The solid substance was colourless, odourless, optically inactive and melted at 83°. It appeared to be a phenol or lactone-like compound, since it does not react with solutions of alkaline carbonates.

IV.—(3) Dyes.

Tephrosia purpurea.—The glucoside of the annual, *Tephrosia purpurea*, (Leguminosæ), which grows widely in India, has been separated by Clarke and Banerjee at Cawnpore. The dry leaves grown locally yielded about 2·5 per cent., and it was found to yield on hydrolysis quercetin, rhamnose and dextrose. The glucoside is apparently identical with rutin obtained from *Ruta graveolens* and with osyritrin which is the glucoside present in *Osyris compressa*.

IV.—(4) Tans and Tanning.

Manufacture of mangrove extract.—The commercial reports of the samples of Mangrove tannin extracts made last year at the Forest Research Institute point out the following defects on account of which the extracts submitted for valuation could not be used for tanning purposes: (1) excess of moisture, (2) presence of mildew, (3) earthy and dull appearance, and (4) iron contamination. The reports also indicate the commercial possibilities of the extract if it could be freed from the above-mentioned defects. The Forest Chemist, therefore, manufactured about 18 tons of Mangrove tannin extract again this year at the Rangoon Government Tannin Factory, eliminating, as far as was possible, the

defects pointed out above. This year no chemicals were used for decolourisation, because all chemical processes of decolourising tanning extracts can only be carried out at the expense of their tannin strength. According to the last year's reports, the best sample was a mixed extract of Mangrove and Myrobalans decolourised by sodium bi-sulphite in the vacuum pans. The colour measurement for red in this extract was 14. The extract made this year was also a mixed extract of Mangrove bark and Myrobalans in the proportion of 1 : 7. Owing to the bad quality of the bark used this year, the total quantity of the extract obtained was only 30 per cent. instead of an estimated yield of 50 per cent., 18 tons being the yield of 52 tons of the mixed material. Average samples of this lot of 18 tons of Mangrove tannin extract were sent to the Imperial Institute, London, and to Dr. Gordon Parker of the Leather Trades Laboratories, Bermondsey and some English firms, for opinion, who have pronounced this year's extract to be very satisfactory. The colour is said to be still too deep for an ideal tannin extract but the Forest Chemist thinks that this is solely due to the bad quality of the bark used. It is generally recognised that the extract prepared from fresh bark with distilled water gives very good results as regards colour. It may be pointed out here that last year the red colour of the extract was brought down from 33 to 14 by means of chemical treatment, and this year without resorting to any chemical treatment it was brought down to 16. Borneo cutch extract, which is recognised as a market standard, has a red varying from 8 to 10. All the other defects pointed out last year were successfully eliminated.

The extract has been sold this year at the rather low rate of £12 6s. per ton c. i. f., Glasgow, it being considered more important to put it on the market at once in order to test its commercial value, than to wait and secure better prices. The Forest Chemist is at present engaged in drawing up a complete report on the prospects of the manufacture of Mangrove and Myrobalans tannin extract in Burma.

Decolourisation of tannin extract.—While experimenting on the manufacture of tannin extracts from red coloured barks of Mangrove and Sal, it was noticed, as is generally admitted, that all chemical decolourisation of the tannin extracts entails a loss in the tannin strength as well as in the tanning properties of the extracts and that the best way to decolourise them would be by a suitable mixture of light coloured tanning materials with the red tanning barks. In continuation of this work, however, as the Forest Chemist was not satisfied with the chemical processes adopted by him for the

decolourisation of the Mangrove and Sal tannin extracts, he tried the action of aluminium and nickel hydroxides. The former proved unsuitable owing to its solubility in water, but the latter added in small quantities effectively decolourises the tannin extracts without showing the defects of the other chemical processes of decolourisation except a small loss in the tannin strength. The colouring matter in such barks as Mangrove and Sal cannot be differentiated from the tannins themselves as contained therein or from certain groups of them and therefore the process of decolourisation consists in fractionally precipitating some of the tannin, which precipitate while settling down takes with it some pectoid and resinous bodies which otherwise keep suspended in the tan liquors. This year only a small amount of preliminary work was done on the decolourisation of tannin extracts by nickel hydroxide and it is hoped that further work on the subject will show whether it would be economical to use nickel hydroxide as such on a commercial basis.

Gambier.—Mr. H. Brumwell in a paper contributed to the Society of Chemical Industry (2) deals with the manufacture, composition and microscopical examination of the extract of leaves and twigs of Gambier (*Uncaria Gambier*).

IV.—(5) Fibres and Papers.

Cellulose investigation.—Mr. William Raitt, Special Paper Expert, attached to the Forest Research Institute, Dehra Dun, gives (38) the following short account of the pulp experiments carried out by him:—

This investigation was begun at the Forest Research Institute Laboratory in March 1911, and is in continuation of that carried on in the laboratory of the Forestry Court of the Allahabad Exhibition during the last cold season. The possibilities of paper pulp production in India now form part of the general work of the Forest Economist, and the results obtained will be incorporated in his report. It has not as yet proceeded far enough to permit of these being recorded, but enough has been done to indicate the vast reserves of raw material suitable for the economical production of cellulose, contained in Indian forests and waste lands, in forms which hitherto have been regarded as waste or unutilisable products. The subject is one that in recent years has received considerable attention in other parts of the world as a result of the rapid growth in the consumption of cellulose for paper making and the many other uses to which this material is now being put, coupled with an equally rapid exhaustion of the chief sources from which supplies have hitherto been drawn, *viz.*, the Spruce and Pine Forests of the Northern Hemisphere. It would seem that the cellulose industry

which is now monopolised by Scandinavia and North America where it is rapidly using up a raw material which takes 40 years to reproduce, and is, therefore, living on and squandering its capital, must eventually migrate to tropical and sub-tropical regions where raw material can be found in species capable of, and growing under conditions which permit of, rapid natural reproduction. In bamboo and in many kinds of fibrous annual grasses, India possesses such species growing under such conditions.

IV.—(6) Flours, Sugars, Starches, Foods.

Phosphorus in Indian food-stuffs.—Referring to the enquiry undertaken last year in connection with rice and beri-beri, Major E. D. W. Greig has published (9) his report on "Epidemic Dropsy in Calcutta" as No. 45 of the Scientific Memoirs by Officers of the Medical and Sanitary Departments of the Government of India. The report gives the results of the analyses of several samples of milled and unmilled rices and other food grains consumed locally. Mr. Hooper has continued the work from a chemical point of view and his results are embodied in a paper on "Phosphorus in Indian food-stuffs" read before the Asiatic Society of Bengal (14). Beyond quoting the analyses of cereal grains before and after milling, an examination has been made of the rice-bran removed in the polishing process and its constituents are discussed. Most of the phosphorus may be removed in the form of phytin, a phospho-organic acid soluble in dilute hydrochloric acid and precipitated by alcohol. Fraser and Stanton have recently shown that the filtrate from phytin is effective in preventing polyneuritis in fowls. The filtrate evaporated to dryness affords 5 to 6 per cent. of phosphoric anhydride and about 1 per cent. of nitrogen and contains the chief basic principles of the rice.

Milk.—The yield of milk and the percentage of butter fat in it has been determined at the Poona dairy farm for Gir and Sind cows by Messrs. Meggitt and Munn over the period 1907-1908, and the following conclusions (24) have been drawn:—

1. In a mixed herd of cows of these two breeds, the composition of the milk may be considered to be fairly constant. The morning milk will contain between four and five per cent. of fat, and the evening milk between five and six per cent. of fat. Under the conditions of the Poona dairy farm, where green fodder is grown and fed throughout the

year, there will not usually be a very marked drop during the rains. The richest milk, taking the whole herd into consideration, is reached in the latter part of the rains.

2. The evening milk is nearly always richer than the morning milk. The difference is, however, less marked in the rainy season than during the remainder of the year.

3. Of the two breeds studied, the 'Gir' gives milk of decidedly poorer fat content than the 'Sind,' the average figures being—

	Morning milk. Per cent.	Evening milk. Per cent.
'Gir' cows	5·2	
'Sind' cows	6·0	6·3

Thus there is a difference of nearly one per cent. in the fat content of the morning milk of these two breeds of cows. There is little difference in the composition of the evening milk.

4. There seems little relationship between the composition of the milk of individual cows and the yield, except that the milk becomes slightly richer at the end of the period of lactation. Apart from this, the milk yielded by a cow is wonderfully constant in composition whatever the amount of milk it is giving.

5. On the other hand, there is a very great variation in the composition of the milk of the animals of one breed. This is what would be expected in breeds of cows which have undergone no selection for many generations.

6. The average lengths of lactation for Gir cows is 40·5 weeks, and for Sind cows 50·8 weeks, but this varies very much, as would again be expected for unselected cows.

7. The yield of milk from a cow rises to its maximum almost at once, and remains almost constant for about the first two-fifths of the lactation period. After this there is a regular and steady decline to the end of the lactation.

8. Among Sind cows there is a tendency for the milk to become richer in fat as the lactation progresses. It seems more obvious in the case of the morning milk than with the evening milk, which usually becomes very marked in the last stage of the lactation. Among Gir cows the rise is not

nearly so constantly found. The figures, in fact, do not seem to indicate any constant relationship between the composition and the period of lactation of the Gir cows.

9. One of the most marked results of the whole investigation is to emphasise the extremely unselected character of herds of even recognised milking breeds like the 'Gir' and 'Sind' in India. The dominance of the individuality of the cows almost renders the environmental influences on the composition of the milk yielded incapable of being detected.

Ghee.—A further communication has been made by Bolton and Revis (3) on the composition of Bombay ghees in which they again emphasise that it is unsafe to depend only on the Reichert-Meissl value, and that the baryta value as obtained by the Avé Lallemant method should always be determined in order to assist in the detection of adulteration. Of seven samples examined five were shown to be adulterated.

Milk products.—In Afghanistan and Baluchistan, Nepal and Tibet a hard form of cheese is manufactured as a portable concentrated food. In the former countries it is a white chalk-like acid substance called 'Kurut' or 'Krut,' in Tibet and Mongolia it is called 'Chura' and is sold in thick square pieces held together on a string. According to analyses made by Mr. Hooper the former contains 58 per cent. of casein and the latter 74 per cent. They both disintegrate in hot water forming a milk-like fluid. Analyses were also made in the Indian Museum of the preparations of curds used largely in Bengal called Chhana and Dahi. Chhana has the properties and composition of a rich cream with a pleasant acidulous taste. It contains twice as much casein as average cream and a lower proportion of butter fat. Dahi or Dadhi is a form of butter-milk in which a proportion of lactose or milk sugar is converted into lactic acid by fermentation.

Dahi and lactic acid.—The acidity of a number of samples of Dahi in terms of lactic acid has been determined in the Municipal Laboratory by the Health Officer of Calcutta. In view of the popularity at present enjoyed by curdled milk products several samples of the tablet preparations of lactic acid bacillary cultures were also tested. These cultures are imported for the production of curdled milk and they were examined both for their power of producing lactic acid and for their bacterial contents. While bazar Dahi after 24 hours contained 1·45 per cent. of lactic acid and had an aromatic odour, four imported preparations produced in sterilised milk from 0·34 to 0·53 per cent. of lactic acid and developed a sour

smell. The great value of lactic acid is its distinct antiseptic property in preventing intestinal decomposition and the multiplication of putrifactive organisms. These experiments show the much greater value of curdled milk as produced in Bengal under the name of Dahi to any artificial preparation produced by a proprietary article to induce fermentation.

Sugar.—Investigations on the sugarcane crop have formed the subject of two communications during the year.

The sugarcanes of Upper India differ in a very marked manner from the canes of other countries and it is well known demand different treatment for their successful culture. It was therefore a necessary preliminary to a survey of the canes of the United Provinces to study the effect of varying some of the cultural conditions on the character of the crop and the yield of sugar. It was thought by Messrs. Clarke, Annett and Zamin Husain (4) as a result of some preliminary experiments in 1908 that some interesting information might be obtained by studying the effect of planting the sets different distances apart.

Starting with a small number of sets per acre planted at wide distances apart, and gradually increasing the number and lessening the distance, it was hoped to ascertain with some degree of certainty the optimum number of sets and the optimum distance apart to plant them.

The experiments were carried out at the Partabgarh experiment station and extended over a period of three years 1908—1911. The results of each year's experiments have been graphically represented and show that where the number of sets per acre is small, *e.g.*, from 3,000 to 9,000, and the distances from centre to centre large, the yield of sugar per acre is liable to considerable variation and the curve for each year's experiments where this number of sets is employed is unsteady, but in some cases each year nearly the maximum yield of sugar is obtained by as few as 6,000 to 8,000 sets per acre where the conditions were ideal. When 12,000 sets per acre are reached the curve representing the yield of sugar becomes stationary and the yield of sugar is not increased by increasing the number of sets per acre beyond this amount. The interpretation of these results appears to be that although a full crop is possible under ideal conditions by the full development of a comparatively small number of sets, under ordinary conditions of cultivation, the risk of obtaining a sufficient number of stools fully developed is considerable if less than 12,000 sets per acre are planted.

The yields of cane per acre are on similar lines to the total yield of sugar, but it is not a general rule that increased yields of cane always mean a correspondingly increased yield of sugar.

In the whole of three years' experiments there is no example of any advantage being derived from using the excessive number of sets per acre that is common in the *desi* method. Indeed there is the disadvantage of rendering the cultural operations exceedingly difficult.

The details are being published as a Bulletin of the Imperial Agricultural Department.

In the "Departmental Records" of the Bengal Agricultural Department (44) Mr. Taylor provides detailed information regarding the composition of twenty-five varieties of Bengal canes. These data are of considerable value and show the composition of the juice, the amount of fibre in the cane and the amount of sugar left unexpressed in the bagass. Like others, he has found that the defect of Indian sugarcane does not lie so much in the quality of the juice, Indian canes being commonly as good in this respect as canes in other countries, but rather in the fact that the amount of fibre in these canes is commonly very high; he found it to vary from 12 to 19 per cent., and in only one cane did the proportion fall below 12 per cent. The effect of a high proportion of fibre is the retention of a high proportion of juice, and consequently of sugar, in the bagass.

IV.—(7) Water.

Hughly river water.—In the last report of the Health Officer of Calcutta (32) some interesting remarks are made on the composition of the river water as it is supplied to the city after filtration in the sand beds at Pulta. Both the inorganic and organic constituents showed the same variations which have been observed in all previous years and which may appropriately be called "seasonal variations." From the beginning of January to the third week of June, the total solids ranged high, varying from 24·5 to 33·8 parts per 100,000, the maximum being observed in the middle of May. With the advent of the rains in the last week of June, the solids rapidly fell to 11·5 parts on the 28th August, as the minimum, rising to 13·5 parts about the middle of November; after that they gradually rose till by the end of December they reached 21·54 per 100,000. The amount of dissolved chlorides varied *pari passu* with the solids, ranging high during the dry months and diminishing during the rains. It was higher during the middle of May, amounting to 5·4 parts per 100,000, coming down to about 0·3 during the whole of October. It then gradually rose till the end of December when it amounted to 0·6 parts. The amount of "albuminoid ammonia" by Wanklyn's process

varied from 0·0032 to 0·0072 per 100,000. The amount of 'oxygen consumed' varied from 0·007 to 0·015 per 100,000, while nitrogen as nitrates ranged from 0·01 to 0·026. The water was found entirely free from nitrites, and free ammonia was found occasionally in traces only. Thus, chemically considered, the water maintained its character as a good potable water.

Calcutta water supply report.

For a period of one year the water in Calcutta has been subjected to a special bacteriological examination by Major W. W. Clemesha, I.M.S. (6). The river Hughly has also been carefully studied as regards its purity at different times of the year. The two important conclusions which have been arrived at in this report are (1) that the Calcutta filtered water is seriously contaminated by leakage of subsoil water into the masonry underground reservoir. This point is not new as engineers have pointed out this previously, but this is the first time that it has been proved bacteriologically to be the case (2). That the water as it comes into the filters during the wet weather months is not sufficiently purified during this time of the year. The Hughly itself is very highly polluted and the 50 hours' settlement, considering the lack of sunlight, and the amount of silt in the water, is hardly sufficient.

The possible methods of increasing the purity mentioned are (1) more storage capacity, (2) mechanical roughing filters, and (3) chemical sterilisation. The Municipality are engaged in considering these suggestions.

Septic tank effluent in Bengal.—The various septic tanks in the neighbourhood of Calcutta have been subjected to a careful scrutiny throughout the year (5). As a rule they are of the "tank latrine" type. The tank is mostly a 5-gallon one as the sewage enters. The following is a rough analysis of what such an effluent should be like when the tank is working satisfactorily.

	Chlorides.	4 hours oxygen.	Dissolved oxygen remaining.		Nitrates.	Remarks on physical character and sterilisation of effluent.
			24 hours.	48 hours.		
Unfiltered . .	8	3·5	·25	·1	*Nil.*	Slightly hazy but no fæcal odour.
Filtered . .	8	1·5	·45	·25	Present in large quantity.	Clear, slight earthy odour.

Most of the latrines are now giving a result very similar to this. A new chlorinating apparatus has been put into use this year so that the effluent is rendered free from intestinal organisms by the addition of liquor of chloride of lime before it passes into the Hughly. The apparatus is extremely simple and works admirably.

Water supplies in Bengal.—A report will shortly be published for the current year of the analyses of the various municipal supplies throughout the province. Most of these supplies are derived from rivers. In the hot weather and sunny months the purity of many of the large rivers is remarkable. Thus a sample taken in April of the middle of the Ganges at Buxar showed no fæcal organisms in 60 c.c. It is obviously very easy to obtain a good drinking water when the source is of such purity. During the time of rains, however, the rivers are very highly polluted and unfortunately in many cases the purifying arrangements are inadequate. Hence there is a considerable falling off in the quality of the filtered water during this time of year.

IV.—(8) Alcoholic Beverages.

Tari.—The alcoholic strength and acidity of fresh *tari* (the juice of palmyra and date palms) and fermented *tari* has been the subject of investigation by Mr. Jenks, the Officiating Director, Central Excise Laboratory (16). For the end in view instruments were carried on tour which admitted of the following determinations:—

(*a*) The acidity.

(*b*) The temperature and density.

(*c*) The alcoholic strength by means of Long's alcoholometer.

It was thus possible to carry out the tests on the "fresh" and "fermented" juice of the date and palmyra palms in the condition in which they are consumed. The tests were made at various places in Bengal, namely, Calcutta, Faridpur, Arrah, Bankipore, Malda, Hughly; and although required for excise purposes, the investigation is of general interest because of the fact that so little reliable information is available on the subject.

The following are the chief results:—

(*i*) No regular differences were observed between the composition of the *tari* of the palmyra, male or female, and the date palm, except that a lower original gravity was observed in a few fresh date *taris*.

(*ii*) The average alcoholic strength of fresh *tari* is about 3·4, that of fermented *tari* about 3·9 per cent. "Fresh *tari* is therefore an alcoholic beverage comparable with German draught beer or English household beer. There are important reservations as regards fresh *tari* to the above, *viz.*, that in places where there is a low night temperature in winter (*e.g.*, Arrah, Faridpur, where the temperature of the juice in the morning is only 58° to 60° F.) fresh date *tari* is totally unfermented and fresh palmyra *tari* averages only 2 per cent. by volume of alcohol."

The maximum strength found was 6·8 per cent. of alcohol.

(*iii*) The original gravity varied from 1,043 to 1,056.

(*iv*) The acidity of *tari* when the collecting pot was taken from the tree varied from about ·05 to ·5 per cent. calculated as acetic acid. In the *tari* obtained from shops it was somewhat higher, namely, ·2 to ·7 per cent. "*Tari*, however, is essentially a refreshing sweet acid beverage of the character of weak lime juice as drunk by Europeans (with say ½ per cent. free acidity) or even of sherbet rather than of a bitter astringent liquid like beer."

IV.—(9) Drugs.

Cannabis sativa.—Preparations of Indian hemp are at present standardised by a physiological method which consists in the administration to dogs of sufficient doses to produce distinct cerebral depression. This method possesses some disadvantages, and in some cases the percentage of experimental error is remarkable. A greater degree of accuracy can be obtained by experimenting on oneself. In 1908, Mr. Hooper suggested a chemical method of valuing Indian hemp, and proposed that the iodine value of the resinous constituents containing cannabinol should be taken as a gauge of the activity. Fresh samples of charas, bhang and ganja which are physiologically potent were found to have a higher iodine value than old samples which were considered inert. Drs. Marshall and Wigner have examined this method to determine its applicability for purposes of standardisation (23). They came to conclusion that physiologically inert or almost inert substances possessing an iodine number approximating to that of the active principle occur in variable proportions in preparation of Indian hemp and hence a chemical method is of no value. They examined approximately pure principles and found that certain fractions

having almost the same general physical characters and iodine value as the original cannabinol were much less active physiologically.

Mr. H. Deane has investigated samples of the extract of Indian hemp used in medicine and has suggested a process for obtaining a more satisfactory preparation (7).

Podophyllum Emodi.—The relative medicinal values of the resins of the two species of podophyllum, the American, *P. peltatum*, and the Indian, *P. Emodi*, have been the occasion of several chemical and physiological enquiries. The rhizome of the Indian plant yields twice the amount of resin as the American, but there has been a difference of opinion in regard to the activity of the resin. The Indigenous Drugs Committee in a recent report gave medical opinion to the effect that the Indian resin was about equal in value to the pharmacopœial resin made from the American root. It has been recognised in the Indian Addendum and it has been suggested that it should be included in the new British Pharmacopœia. Mr. J. C. Umney (45) on behalf of the Indigenous Drugs Committee has tested a supply of the Indian rhizome collected after fruiting and in a paper read before the British Pharmaceutical Conference showed that it afforded 10·79 per cent. of resin, and 60·3 per cent. of this consisted of picropodophyllin or podophyllin, the recognised active principle. Dr. W. E. Dixon also reported favourably upon its efficiency. In the Indian Museum report for the past year it is recorded that the roots of cultivated plants of *P. Emodi* in Kashmir yield between 13 and 14 per cent. of resin.

Withania somnifera.—The root of this solanaceous plant, well known in India as "Asgandh," has been investigated by Dr. F. B. Power and Mr. A. H. Salway (34). Both the roots and overground portions of the plant responded to tests for an alkaloid. A number of substances were present in the root, leaves and stems; these included essential oil, sugar, hentriacontane, a phytosterol, palmitic, stearic, cerotic, oleic and linolic acids, and ipuranol. From the root were obtained a new monohydric alcohol, withaniol, an amorphous alkaloidal principle, which on treatment with alkali yielded a crystalline base. The leaves and stems yielded the following new compounds: a monohydric alcohol, somnirol; a dihydric alcohol, somnitol; and an acidic hydrolytic product, withanic acid. The authors conclude that *Withania somnifera*, unlike some other solanaceous plants, contains no mydriatic alkaloid, and physiological tests, conducted on a dog, failed to confirm the sedatic or hypnotic properties attributed to it.

Bibliography.

1. Banerjee, Manindra Nath. An investigation into the causes of the differences in the action of sodium and potassium on water. (*Chemical News, cii, 1910, 319.*)
2. Brumwell, H. . Examination of Gambier. (*Jour. Soc. Chem. Ind., xxx, 1911, 475.*)
3. Bolton & Revis. Bombay Ghee. (*The Analyst, 1911.*)

3A. Clarke, G., & Banerjee, S. C. A glucoside from *Tephrosia purpurea*. (*Trans. Chem. Soc., 1910, p. 1333.*)

4. Clarke, G., Annett, H. E., & Syed Zamin Husain. Experiments on the cultivation of sugarcane at the Partabgarh Experimental Station. [*Bull. Imp. Dept. Agr. (in the press).*]
5. Clemesha, Major W. W. Sewage Disposal in the Tropics, 1910.
6. Clemesha, Major W. W. Calcutta Water Supply Investigation Reports, I and II.
7. Deane, H. . . Extract of Indian Hemp. [*Pharm. Jour., (4) 33, 161.*]
8. Dey, B. B. & Sen, H. K. Interaction of Hydrazine Sulphate with Nitrites. (*Jour. Asiat. Soc., Beng., vii, No. 4, 109.*)
9. Greig, Major E. D. W. Epidemic Dropsy in Calcutta. (*Sc. Memoirs by Officers of Med. and Sanitary Dept., 45.*)
10. Hanausek, J. F. Report on the Microscopic Features of Bamboo and Himalayan Spruce Pulp, samples forwarded by W. Raitt. (*Papier Fabrikant, June 1911.*)
11. Hooper, D. . . The Soy Bean in India. (*Agr. Ledger, No. 3 of 1911.*)
12. Hooper, D. . . The Composition of Indian Yams. (*Jour. Asiat. Soc., Beng., vii, 1911, 57.*)
13. Hooper, D. . . Some Asiatic Milk Products. (*Jour. Asiat. Soc., Beng., vii, 1911, 63.*)
14. Hooper, D. . . Phosphorus in Indian food-stuffs. (*Jour. Asiat. Soc., Beng., vii, 1911, 313.*)
15. Hooper, D. . . *Indian Museum Report for 1910-11.*

16. JENKS, R. L. . Report on the Alcoholic Strength and Acidity of Fresh Tari and Fermented Tari in Bengal, Eastern Bengal and Assam. *Govt. Press, Calcutta, 1910.*

17. LANGMUIR, A. C., & WHITE, F. S. The Analysis of Shellac. (*Jour. Soc. Chem. Ind., xxx, 187.*)

18. LEATHER, J. W., & MUKERJEE, J. N. The Indian Saltpetre Industry. (*Bull. No. 24, Agr. Res. Inst., Pusa.*)

19. LEATHER, J. W. Records of Drainage in India. [*Mem. Dept. Agr., India, Chem. Series, ii (in the press).*]

20. LEATHER, J. W. Water requirements of Crops in India, II. (*Mem. Dept. Agr., India, Chem. Series, i, No. 10.*)

21. MANN, H. H., & TAMHANE, V. A. The Salt Lands of the Nira Valley. (*Dept. of Agr., Bom., Bull. No. 39 of 1910.*)

22. MANN, H. H., JOSHI, N. V., & KANITKAR, N. V. The "Rab" system of rice cultivation in Western India. [*Mem. Dept. Agr., India, Chem. Series, ii (in the press).*]

23. MARSHALL, C. R., & WIGNER, J. H. Standardisation of Indian hemp. (*Brit. Med. Jour., May 1911.*)

24. MEGGITT, A. A., & MANN, H. H. The composition of the milk of some breeds of Indian cows and buffaloes and its variations. Part I.—The milk of some breeds of Indian cows. (*Mem. Dept. Agr., India, Chem. Series, ii, No. 1.*)

25. MENON, A. K. . Some Indian Oils and Fats. (*Jour. Soc. Chem. Ind., xxix, 1910, 1428.*)

26. NEOGI, P., & ADHIKARY, B. B. Chemical Examination of Aurvedic Metallic Preparations (roasted iron). (*Jour. Asiat. Soc., Beng., vi, No. 8, 331.*)

27. NEOGI, P., & ADHIKARY, B.B. On the preparation of Phenyl nitro-methane by the interaction of mercurous nitrate and Benzoyl Chloride. (*Jour. Asiat. Soc., Beng., vi, 500.*)

28. NEOGI, P., & ADHIKARY, B. B. Reactions in the presence of nickel. (*Jour. Asiat. Soc., Beng., vi, 593*), (*translation in Zeits. fur. Anorgan. Chemie, 1910, Band 69, 209*).

29. Neogi, P. . . Trialkylammonium Nitrites. (*Jour. Chem. Soc., Vol. 99, 1911, 1252.*)

30. Neogi, P., & Adhikary, B. B. Preparation of Ammonium Nitrate by sublimation of ammonium chloride and alkali nitrite. (*Trans. Chem. Soc., Vol. 99, 1911, 116.*)

31. Neogi, P. . . Orthophosphoric acid as a Dehydratrial Catalytic Agent. Part I.—The condensation of acetone in presence of Phosphoric Acid. (*Jour. Chem. Soc., Vol. 99, 1911, 1249.*)

32. Pearse, T. F. . Report of the Health Officer of Calcutta for 1910.

33. Phillips, P. P. . Gum of *Bombax malabaricum*. (*Jour. Soc. Chem. Ind., xxx, 1911, 469.*)

34. Power, F. B., & Salway, A. H. The Constituents of *Withania somnifera*. (*Jour. Chem. Soc., Vol. 99, 1911, 490.*)

35. Puran Singh . The Analytical Constants of Shellac, lac resin and lac wax. (*Jour. Soc. Chem. Ind., xxix, 1910, 1435.*)

36. Puran Singh . Note on the use of nickel hydroxide in tannin estimation. (*Jour. Soc. Chem. Ind., 1911.*)

37. Raitt, W. . . Paper and Paper-pulp in India. (*Indian Industrial Conference, 1910.*)

38. Raitt, W. . . Paper-pulp testing at the Forestry Court Cellulose Laboratory, U. P. Exhibition. Parts I, II, III. (*Indian Forester, Jan., Feb., Mar., Apl. and May 1911.*)

39. Raitt, W. . . Papier und Papierstoff auf der ausstellung zu Allahabad. (*Papier Fabrikant., Feb. and June 1911.*)

40. Ray, P. C. . . Influence of minute quantities of Ferric salts and of manganese nitrate on the rate of solution of mercury in nitric acid. (*Jour. Chem. Soc., 99, 1911, 1012.*)

41. Ray, P. C., & Rakshit, J. N. Methylammonium Nitrite. (*Jour. Asiat. Soc., Beng., vii, No. 4, 91. Jour. Chem. Soc., 99, 1911, 1016.*)

42. Schimmel & Co. Semi-Annual Reports, October 1910 and April 1911.

43. Sircar, A. C., & Dutta, J. M. — The reaction between Permanganate of Potash and Manganese Sulphate in acid solution. (*Zeits. fur Anorgan. Chemie, June 1910.*)

44. Taylor, C. S. — Notes on classification and examination of the canes at present indigenous to Bengal. (*Dept. of Agr., Bengal, Deptl. Records, No. 3.*)

45. Umney, J. C. — Further note on *Podophyllum Emodi*. (*Pharm. Jour., 4, 33, 157.*)

46. Watson, E. R., & Dutta, J. M. — The relation between Chemical Constitution and Monoazo dyes and their fastness to light and other agencies. (*Jour. Soc. Chem. Ind., xxx, 1911, 7-9.*)

47. Watson, E. R., & Dutta, J. M. — The relation between Chemical Constitution and fastness to light and other agencies of poly-hydroxy-benzophenelene dyes. (*Jour. Soc. Chem. Ind., xxx, 1911, 196.*)

ASTRONOMY.

BY

J. H. FIELD, M.A., B.Sc.,
Offg. Director-General of Observatories.

Solar physics.—Researches in solar physics are carried on under the direct control of the Government of India at Kodaikánal, the Director being Mr. J. Evershed and the Assistant Director Mr. T. Royds. The chief instruments are:—

(*a*) A spectroheliograph made by the Cambridge Scientific Instrument Company, the object of which is to take photographs of the sun using the light emitted by one chemical element only. In this apparatus a stationary image of the sun is made by a 12-inch triple-achromatic lens of 20-foot focus, fed by an 18-inch Foucault siderostat. Close up to the image and somewhat longer than its diameter is the narrow vertical slit of a spectroscope arranged in such a manner that the light which has passed horizontally through the collimating lens shall be deflected through two right angles by two prisms and a mirror, and so shall emerge from the camera lens parallel to its original direction. This light then falls upon another vertical slit which can be adjusted in such a position as to allow light of any desired wave length to pass through. In the Kodaikánal spectroheliograph the collimating and camera lenses each of 5-inch aperture and 6-foot focal length, together with the prisms and slits, are attached to a rigid framework, while immediately in contact with the slit last described is a stationary photographic plate within a fixed camera. The rigid framework is capable of motion in a horizontal plane in such a manner that the primary slit may pass uniformly across the image of the sun while the secondary slit will move at an equal rate across the sensitised plate; and as in each position an image will be formed at the second slit by light of the desired wave length and no other light can emerge, the result of the movement upon the plate is a complete image of the sun in monochromatic light. At

present the H and K lines of calcium are largely used on account of the convenience afforded by the width of their absorption shading and the fact that the centre of the dark line is frequently 'reversed,' *i.e.*, is bright instead of dark, indicating that the calcium vapour is abnormally hot in the higher levels of the solar envelope. A photograph so obtained shows bright clouds—called 'flocculi'—of calcium vapour scattered about over the sun, and gives a large amount of information that is not otherwise obtainable. Further, by causing the slits to move more slowly the exposure may be lengthened sufficiently to give photographs of the 'prominences' projecting from the sun's margin.

(*b*) Two 6-inch refractors, with one of which an Evershed spectroscope has been used since November 1904. These are used for visual examination of the sun and for spectroscopic study of spots and prominences.

(*c*) A spectrograph consisting of an 11-inch polar siderostat with a 6-inch Grubb lens of 40-foot focus. This is used with a 3½-inch concave grating of 10-foot focus mounted on Rowland's plan. A 2-inch parabolic grating can be substituted for the concave grating and a collimating lens may be employed with either grating to cure astigmatism.

(*d*) A photoheliograph by Dallmeyer. With this a photograph of the sun in ordinary light is made daily when possible. Originals are sent to Greenwich for the use of the Solar Physics Committee for those days for which photographs are not available from Greenwich or Dehra Dun.

(*e*) An 18-inch parabolic mirror (the property of the Director) is mounted in the spectroheliograph room immediately in front of the 12-inch photo-visual lens. It is used to form the solar image on the slit plate of the high dispersion spectrograph. The mounting is on rollers and the mirror can either be moved into position in front of the lens with its centre in the axis of the beam of light coming from the heliostat, or it can be pushed to one side so as not to obstruct the light incident on the lens during the operation of the spectroheliograph and associated instruments.

(*f*) A high dispersion spectrograph mounted on piers in the spectroheliograph room. This is fitted with special arrangements for rotating the sun's image on the slit plate, and

for accurate guiding during long exposures on sunspots. Plane gratings are used in this spectrograph—either a $3\frac{1}{4}$-inch by Rowland or a 6-inch by Michelson. It has been largely used for photographing spot and prominence spectra.

(*g*) An autocollimating spectroheliograph for photographing the sun's disc in the hydrogen radiations. This has been completed and brought into successful operation. Daily photographs are now obtained with the slit set at the centre of the line H_α, and among many interesting features the plates taken with this instrument show the prominences not only at the sun's limb, but also projected on the disc where they appear as very dark absorption markings.

2. **Routine work.**—In addition to the use of the spectroheliograph and photoheliograph the routine work includes visual examination of sunspots and faculæ, observations of widened and displaced lines in sunspot spectra and spectroscopic observation of prominences. A monthly article describing the solar activity is contributed to the "Monthly Weather Review," while for more technical purposes bulletins and memoirs of the observatory are issued; of the former 23 have appeared while of the latter the first has been published.

3. **The Solar Constant.**—The method of estimating changes in the solar constant by comparing the intensity of moon-light with first type stars has now become part of the routine work, and photographic comparisons are made whenever the atmospheric conditions permit. A good series of photographs was obtained during five of the thirteen lunations; the stars used were Alpherat, Rigel, Sirius, Procyon, and Regulus, all assumed to be invariable in their light.

A suitable photometer for measuring the plates has not yet been obtained.

4. **Spectroscopic investigations.**—A large number of photographs of the spectra of sunspots and of prominences has been obtained with the high dispersion spectrograph. A smaller number of spectra of undisturbed regions on the sun has also been obtained with the same instrument and with the concave grating spectrograph. In studying these plates the main lines of investigation are those connected with the movements of the gases in sunspots, and with the general circulation in the solar atmosphere. The plates of prominence spectra are measured for determining the angular speed of rotation of these objects at considerable heights above the chromosphere.

A few measures have been made of the Zeeman separations of a line in the red region of the spectrum which is doubled in sunspots owing to the magnetic field; and some lines in the ultra violet which are normally single in spots have been recorded as double at a time when a great eruption of gases was in progress. This indicates that a greatly increased magnetic field may accompany such outbursts.

5. **Radial motion in sunspots.**—The photographs of spot spectra obtained during the year have confirmed the previous results as regards the outward accelerating movement of the low level gases over spots. Owing to the comparatively small number of moderate sized or large spots which have appeared during the year not much new evidence has been obtained, and very few of the plates were taken under sufficiently favourable conditions for investigating the small component of motion at right angles to the radial motion which was discovered in the case of six spots previously investigated and mentioned in the last report.

Much of the material recently obtained relates to the behaviour of the high level gases in the chromosphere in and near spots. It had previously been found that the calcium lines H and K, and the hydrogen line C, were systematically displaced over spots, the displacements being in a direction opposite to those of the low level lines of iron and other metals, thus indicating an opposite direction of movement of the high level gases which flow inwards towards the centre of a spot. The more recent results confirm this, and show that the emission as well as the absorption lines of H and K are affected by this inrush. A marked exception was however found in a single instance; a spot group which appeared on the eastern limb on September 20th, 1910, was photographed in the H and K region of its spectrum several times during its passage across to the western limb, and in none of the plates is there any evidence of inward movement either in the emission or absorption lines of H and K. The principal spots of the group were very much encroached upon by bright calcium clouds which may have masked the motion effect. The effect is most strongly shown in those spots which are of a symmetrical outline and not undergoing active change.

6. **Vertical movement of calcium vapour.**—A large number of measures have been made of the wave-lengths of the emission lines H and K in the faculæ in various situations on the sun's disc. The results so far obtained show that in general these lines are displaced towards the red when the faculæ are situated near the centre of the disc. The displacement tends, however, to disappear when the faculæ are observed near the limb. This appears to show conclusively that the displacement is due to motion in the line of sight, and not to pressure

which would displace the lines towards the red in all situations. The movement is one of descent, that is to say, the bright calcium clouds in the disturbed regions near spots are descending relatively to the iron vapour in the reversing layer. This is a somewhat unlooked for result although it has already been announced by Deslandres as a result of some measures made by him. It has been shown by St. John that the emission lines of H and K in undisturbed regions are displaced systematically towards the violet near the centre of the disc, and indicate a rising movement; the few measures which have been made here confirm this point also.

The measures will be continued with a view of obtaining reliable estimates both of the descending and ascending movements.

7. The Observatory is co-operating with the "International Union for Solar Research."

8. There is also at Poona, under the Government of Bombay, the Takhtasingji Observatory, where research in solar physics is carried on by Mr. Naegamvala. The chief portions of the equipment are:—

(*a*) A Foucault siderostat with an 8-inch image lens for use with a spectroscope.

(*b*) An equatorial refractor with a Cooke 6-inch triple photovisual lens. This is provided with two 45° objective prisms, and a prominence spectroscope with a Thorpe transmission grating has been constructed locally for attachment to it.

(*c*) An equatorial reflector with a 20-inch mirror by Common. A focal plane ultraviolet spectrograph is used for stellar spectra.

The twelve 'most widened' lines in sunspot spectra are observed daily and the results forwarded to Sir Norman Lockyer, and a close agreement is maintained with the observations made at South Kensington. The observatory is also co-operating with the International Union for Solar Research, and is observing the region 5300 to 5500 for all lines affected in sunspots.

9. **Solar radiation.**—Two Angstrom pyrheliometers were in use during the year at Simla, and one at Kodaikánal.

METEOROLOGY.

Owing to changes in the gazetted staff of the department and to absences on leave, the progress of current researches was slow and little new work was possible.

Examination of the upper atmosphere.—This work involves the measurement of pressure, temperature, humidity, wind direction and wind velocity at all points from ground level up to heights of fifteen or sixteen miles, and was started primarily with the object of throwing light on the problem of monsoon forecasting. The following considerations show the necessity for this work. It was realised by Blanford, when in 1875 he began the organisation of the system of ground level observatories, that surface observations alone were unlikely to elucidate completely the problem of quantitative or even of qualitive forecasting.* He anticipated that when widely extended ground level data had been collected and analysed, it would probably become necessary to extend the observations to those higher levels in the atmosphere where occur the changes of meteorological conditions which are directly responsible for changes of weather. Blanford's own work, however, was necessarily almost confined to the collection and analysis of ground level conditions over India itself. He examined fairly exhaustively the influence on monsoon rainfall of local surface conditions, and discovered the effects of snowfall in the Himalaya, and of the distribution of pressure, temperature, and winds in India.

His successor, Sir John Eliot, with monsoon forecasts in view, extended the area over which ground level observations were taken, and before his retirement had discussed the greater part of the additional data collected. Taking into account the results of Blanford's work and of his own extensive researches, together with certain definite relations, established by Sir Norman Lockyer, between pressure in India, Australia, South Africa and South America, he finally arrived at the conclusion that little further advance could be made until reliable data for the whole area affected by the monsoon from its source to its sink had been collected and examined.† He advocated this as the next step forwards in the work, but he anticipated that to solve the problem completely an examination of conditions in the upper atmosphere would also be necessary, and he therefore proposed to obtain such observations over India. He hoped that in addition to furnishing important information for seasonal

* See his "Vade Mecum," Vol. II. p. 1.

†(See Indian Meteorological Memoirs, Vol. XVI. 1903-05, p. 307.

forecasts the observations on the upper atmosphere would assist materially the work of daily forecasting by providing data independent of localised ground level actions. These latter in India are very marked, and are liable to obscure to some extent the operation of general causes of weather change.

Dr. G. T. Walker, who assumed charge of the department in 1904, was able still further to extend the scope of ground level observations. He examined more thoroughly than Blanford or Eliot had done the influence of solar disturbances, and carried out the analysis, in regard to Indian rainfall, of ground level data collected from all parts of the globe. He demonstrated the existence of marked numerical relationships between monsoon rainfall and conditions in Australia, the South Indian Ocean, Africa, and South America, and showed that the effect of observed solar disturbances was comparatively small; but he finally arrived at the conclusions that not more than half of the factors controlling monsoon rainfall had been discovered from the data available; that the factors discovered were inadequate to give reliable forecasts; and that a considerable number of years of geographically extended observations at the ground level would be necessary to give a reasonable probability of further appreciable progress. The anticipations of Blanford and Eliot were thus borne out inasmuch as it became clear that in order to make anything more than extremely slow progress it was essential to undertake active upper air research.

The upper air experiments were begun in 1905 when about three weeks' work from August 26th to September 12th was carried out with kites near Karachi. In the following year the work was carried on in Belgaum for one week at the end of May and three weeks in August and September. In 1907 at the end of July and the beginning of August another series of observations was made during about four weeks at Belgaum and a few days in the Bay of Bengal and the Arabian Sea. The sea observations were taken by an officer proceeding home on leave.

The results obtained from the four brief periods of observation were fairly definite, and were published in the Memoirs of the Meteorological Department, Vol. XX. The Karachi observations indicated that the moist sea winds were replaced at about 1,500 feet by exceedingly dry hot winds which showed evidences of belonging, as was previously suspected, to a large general air movement from the deserts of Baluchistan into India, while the lower moist winds were of comparatively local origin, appearing and disappearing with the diurnal temperature changes of the sea-

board. The upper currents were steady and no change in them occurred, during the period of observation, of a nature to produce changes in the prevailing weather conditions of the surrounding regions. The observations in May 1906 at Belgaum were secured as representing pre-monsoon conditions, and revealed a structure in the atmosphere, somewhat similar to that observed at Karachi in August and September 1905. Comparatively moist low-level westerly winds were replaced at heights of 2,000 to 3,500 feet by very dry winds from a more northerly direction. The thunderstorms which usually characterise the month of May were abnormally few, and no opportunity occurred of examining the state of the upper air associated with them. Later in the same year, in August-September, actual monsoon conditions were sought for, the period of work including the transition from a "break" in the rains to a renewal of monsoon activity. The thickness of the moist monsoon current before its complete re-establishment was found to vary from 4,500 to 7,500 ft., *i.e.*, the current was 3,000 ft. thicker than the corresponding moist parts of the winds in May, preceding the monsoon proper. Time did not allow of the experiments in September being continued until the monsoon was fully re-established so that the question of the total depth of rain-bearing winds during a time of active monsoon still remained unsettled.

In the following year the only time available for the work again happened to occur in the transition period between a "break" and the renewal of the monsoon. On this occasion the upper limit of the moist current exceeded 9,000 feet, the maximum height reached. It was observed that the re-establishment of the monsoon took place in the form of a series of rain squalls, the same type of disturbance as dust-devils and water spouts, in which winds were very localised and extremely violent at some distance above ground. These conditions preceded by over two weeks the full re-establishment of the monsoon, and it was unfortunate that the work could not be continued into the important period then beginning. Observations over the Arabian Sea were practically confined to the sailor's "*soft place*" in the monsoon area, being taken on three days during the first half of the direct passage from Colombo to Aden. Here, as the kite rose, none of the abrupt changes of humidity and wind which are so characteristic of the land area, were observed. The moist current was about 1,200 ft. in thickness, and above it humidity showed the entirely new feature of a gradual decrease to a low value. It was found that in those latitudes, whatever the direction of the wind at the sea surface might happen to be, the winds above 5,500 ft. were from due west, and carried air along continuously from the Arabian Sea area towards the extreme south of India.

In 1909 no further work of this kind was practicable, and it may be said that during the whole time since the experiments were begun the difficulties in the way of detaching a gazetted officer for considerable periods to carry on the work in the plains have proved very great indeed. In view, however, of the importance of obtaining continuity in the observations and of the impossibility of carrying out the instrumental work in Simla, much time during the year 1909-10 was devoted to the instruction, of an Indian observer from the office staff at Simla who could be spared to go to the plains. The observer chosen had shown some aptitude for the work, and it was hoped that he would be able to calibrate the instruments and liberate the balloons with native help alone, general supervision being exercised by the organising officer by correspondence from Simla. The observer with a few men to help him was established at Jhang in May 1910, and the preliminary work consisting of the liberation of a series of pilot balloons and the plotting of their courses was begun. The system was found to be entirely satisfactory for this section of the work, which involved mere theodolite observations and the calculation from them of heights, wind velocities and wind directions. When, however, the instrumental work was attempted, the many trifling difficulties which must necessarily arise in research operations were found to be insuperable by correspondence, and after long trial it was reluctantly concluded that the work demanded a greater knowledge of the principles of the instruments and of the essential objects of the investigation than could be expected of an observer without a scientific education. The value of the pilot balloon observations alone was considered insufficient to justify the expenditure on the existing establishment, and the work was consequently brought to a close on the 31st March 1911.

Steps are now being taken to secure the necessary personal supervision of an organising officer during a considerable portion of the year, and it is hoped that the experimental investigation may be resumed in 1913 at Allahabad. The work will be directed chiefly towards determining the extent to which enquiry in the upper atmosphere may be expected to throw light on the problem of monsoon and other forecasting.

During the course of the pilot balloon ascents at Jhang, similar balloons were liberated on many days in Simla, and this practice was continued after the closing of the Jhang establishment.

The work of analysing the observations which have already been made is progressing, and it is hoped that it will be possible to publish the results of the analysis in the course of the year 1911-12.

Data from logs of ships in the Indian Ocean.—The collection of these has been continued and they have proved useful in connection with the work of storm-warning, but it has not been possible to put in hand their systematic analysis.

Publications.—The customary Daily Weather Reports of Simla, Calcutta, Bombay and Madras; the monthly and annual supplements to the Simla Daily Weather Report; the Monthly Weather Reviews, the Annual Summary, and various administrative pamphlets were issued during the year: but no departmental memoirs were published.

TERRESTRIAL MAGNETISM.

Magnetic observatories.—*Bombay (Alibag).*—The Bombay Observatory, formerly maintained by the Local Government at Colaba, was moved to Alibag in consequence of the introduction of electric trams into the city: it is now directly under the Government of India, the Director being Mr. N. A. F. Moos. The chief instruments are a set of magnetographs of the Watson pattern and a Schulze earth-inductor, in addition to ordinary magnetometers and dip-circles. All have given satisfactory results through the year. A set of sight-reading instruments of Eschenhagen pattern has been obtained and will be used as a check on the Watson instruments as well as for special observations. The results of the sixty years of observations at Colaba have recently been published.

2. *Dehra Dun, Kodaikánal, Barrackpore and Toungoo.*—These observations were started as base stations in connection with the Magnetic Survey of India, and are all equipped with Watson autographic instruments for declination, horizontal intensity and vertical force. Instead of dip-circles, earth-inductors of the Schulze pattern have been set up at each place. Good results have been obtained through the year, with the exception of the vertical force instrument at Toungoo; this instrument was readjusted in July 1911, but it is feared that the traces for several months previously will have to be rejected. The repairs to Dehra Dun Observatory have been delayed, owing to the special observations asked for by the Royal Society in connection with the Antarctic expedition; they will be carried out at the earliest opportunity.

3. The mean values of the magnetic elements at the Survey observatories for 1910 are as follows:—

Observatories.	Lat.	Long.	Declination.	Dip.	Horizontal force.	Vertical force.
					C. G. S.	C. G. S.
Bombay . .	18° 36′ N.	72° 52′ E.	0° 57′·7 E.	28° 38′·5	·36245	·16148
Debra Dun .	30° 19′ N.	78° 3′ E.	2° 31′·9 E.	48° 54′·8	·33357	·32010
Barrackpore .	22° 46′ N.	88° 22′ E.	0° 55′·5 E.	30° 42′·2	·37329	·23168
Kodaikánal .	10° 14′ N.	77° 28′ E.	0° 55′·0 W.	3° 45′·2	·37485	·02459
Toungoo . .	18° 56′ N.	96° 27′ E.	0° 24′·9 E.	23° 2′·1	·38801	·16498

4. **Magnetic Survey.**—The general scheme was to execute a preliminary survey of the whole country and a detailed survey of those areas where, owing to local irregularities, further information was required. The preliminary survey was to consist of observations of declination, intensity and dip at about 1,100 stations, and measurements were to be made in successive years at about 22 'repeat' stations in order to effect the elimination of secular variation.

Field work was begun in November 1901, and up to the end of the field season 1909-10 1,324 field stations had been occupied and 23 repeat stations established, in addition to 24 stations on the Seistan trade route where declination had been observed; observations had also been repeated at 142 old field stations, of which 15 have been re-occupied on two occasions. In the detailed survey 193 stations had been occupied.

During the year under report four detachments were employed.

One detachment was engaged in re-observing a number of selected old field stations, the sites of which were permanently marked for future identification.

A second detachment carried out a detailed survey of the Bengal coal-field in response to numerous requests for accurate values of magnetic declination; in addition, at the request of various Companies, six meridian lines were laid down to facilitate the testing of surveying compasses.

The third detachment was intended for the survey of the Andaman and Nicobar Islands, for which the census operations appeared to offer a favourable opportunity. At the last moment, however, the arrangements fell through, and after observing three new stations in the Andamans and the repeat station at Port Blair the detachment returned to

India, and was employed on detail survey in the vicinity of Buxar and Chupra.

The fourth detachment was employed on office duties during the cold season and took the field in April in Kashmir. Twenty new stations were observed, the detachment returning to recess early in July.

5. The officer in charge, Lieutenant H. T. Morshead, R.E., observed at 22 repeat stations, and made comparative observations at the four Survey base stations and at Alibag.

During the season full sets of magnetic observations were taken at 29 new and 80 detail survey stations, while 56 old field stations and 23 repeat stations were re-occupied.

6. During the recess season the computation of the field work carried out during the cold weather of 1910-11 was completed, and the reduction and tabulation of the base station results for 1910 were in hand and nearing completion. In addition to this work the investigation was continued of the instrumental divergences in measurements of H. F., to which reference was made last year.

7. The latter question has proved far more complex than a perusal of last year's report would suggest; it may be considered under the heads of (i) personal error, (ii) changes in the constants of magnetic distribution, (iii) changes in the moment of inertia of the magnet, (iv) thermometric errors, and (v) instrumental changes not otherwise accounted for.

8. *Personal error.*—It becomes increasingly evident that the observed discrepancies are in the main due to "personal error," to which only a passing allusion was made in last year's report, the real significance of this factor having been under-estimated for lack of sufficient data.

By "personal error" in this connection is meant the difference in the mean magnetic moment obtained when the vibration observations are taken—

(*a*) by the eye and ear method,

(*b*) by chronograph.

Experiments have shown that while for the majority of observers results are practically identical when using the chronograph, serious divergencies, as in the case of star transit observers, are found in the former method; further, "personal error" is not necessarily a constant for a

particular observer, but may vary during the limits of a single field season (*cf.* Chauvenet, "Spherical and Practical Astronomy," Vol. II, pp. 189 to 193). The cause of the error lies in the estimation of the time interval elapsing between the beat of the clock and the transit of the centre of the scale by the moving cross wires, the magnitude of the error varying with the amplitude of the arc of vibration, which in India diminishes by one half during the observation. In this respect the observation differs from that of star transits. To show the magnitude of the effect of a timing error we may take a magnet having a magnetic moment of 900 C. G. S. units, and a moment of inertia of 3·4. Then a difference of 0·2 second in the mean value of the several series of 162 vibrations will produce at Dehra Dun an error of 0·4 unit in magnetic movement and an error of 14γ in H. F., *i.e.*, such small errors as 0·1 second in opposite directions in the two series of vibrations would be sufficient to account for the discrepancy.

This source of error does not appear hitherto to have received the attention it deserves in connection with magnetic work. The magnetic moment of a magnet in ordinary field use changes very slowly, and the error introduced by taking as its value that found at any time by the observer in the field, using the eye and ear method, can be avoided by the safer procedure of deducing the magnetic moment for the time in question from the chronographic determinations at the beginning and end of the field season, when those determinations show that the whole change in the interval has been small. For base stations chronographic determinations need be taken only once or twice a month, while for field instruments the determinations must necessarily be confined in India to the bi-yearly comparisons at head-quarters.

9. *Distribution constants.*—As regards the distribution constants P and Q, it has been found in the course of the investigation that real and permanent changes are rare, though apparent and temporary changes (actually due, most probably, to accidental errors of observation) may be comparatively frequent. Real changes need only be looked for when there has been a large dislocation of the value of the magnetic moment, and even in such cases they are infrequent.

10. *Moment of inertia.*—Changes in the moment of inertia do undoubtedly occur in practice, owing to the wear to which the magnets are subject in handling; and the value must therefore be redetermined from time to time. The largest effect of this kind yet noted was in the Survey standard, which showed a progressive change equivalent to a fall of 24γ in H. F. during a period of eight years. In the evaluation

of the constants the observations for determining the moment of inertia give perhaps the least satisfactory results owing to their high probable error.

11. *Thermometric errors.*—These include (1) the gradual zero-creep which is inseparable from all mercury-in-glass instruments, and (2) those due to unexpected changes of correction, such for instance as result from a slight dislocation in the mercury column. Errors of the former class are to be guarded against by periodic redeterminations of the freezing point, but those of the latter are liable to give trouble from their liability to appear suddenly and to change irregularly in amount. Instances of this particular class are not infrequent in India, especially in horizontal thermometers. They are presumably due to imperfect manufacture resulting in a slow emission of gas from the walls of the tube and its eventual collection, in the form of a bubble, as a break in the mercury column. In one case it was found that an apparent change in one of the field instruments in 1904-05 coincided with a change of thermometer used with it.

12. *Instrumental changes not otherwise accounted for.*—Apart from actual damage to a magnetometer resulting in serious alteration to the assumed deflection distances, it is difficult to imagine how an instrumental change can occur, other than one in the constants which are periodically redetermined in the ordinary course. In last year's report, paragraph 6, an example of instrumental change in the standard was given, but it has since been ascertained, from information not available at the time the report was written, that the figures which indicated the effect were based on erroneous data, and that the change had not actually occurred.

13. *Importance of the investigation of the causes of instrumental differences.*—Since the personal error is found to be the main cause of observational discrepancies, it follows that in the use of the Survey standard there is practically as much liability to observational error when using the eye and ear method as with the field instruments: it is consequently to be understood that apparently unimportant but unexplained divergences in comparative results raise a doubt which extends even to the results of the standard magnetometer. The necessity, therefore, arises not merely of correcting the field instruments to the standard, but also of correcting the observations from the standard itself.

It proves then to have been advantageous that the discrepancies in comparative results were given more careful attention than they might

previously have appeared to call for. The elimination of the various errors is to a great extent a question of "trial and error" and the process is necessarily laborious; the final test lies in a comparison of the monthly mean values of H. F. at the various observatories after eliminating secular change. For the purpose of this comparison it is necessary to have the same series of selected days at each observatory, and experience has shown that in order to eliminate as far as possible the effects of accidental disturbance, it is desirable to obtain the mean value by planimeter measurement instead of by the usual process of measuring hourly ordinates.

14. For the next field season three detachments only will be available, the strength of the party having been permanently reduced by one detachment. Of these, two will be employed on detail survey mainly in Central India; while the third will be utilized in office duties in Dehra Dun.

GEOLOGY.

BY

H. H. HAYDEN, C.I.E., B.A., B.E. (T.C.D.), F.G.S.,
Director, Geological Survey of India.

CONTENTS.

Mineralogy and Petrology.

Indian arsenates.

1. In his monograph on the manganese-ore deposits of India[1] Dr. Fermor has given a preliminary account of two occurrences of arsenates in Indian manganese mines. The best material available was forwarded to the British Museum (Natural History) for further investigation, which was kindly undertaken by Dr. G. T. Prior and Dr. G. F. H. Smith. From the summary at present available of their papers read before the Mineralogical Society of London[2] it appears that the green mineral found at Kajlidongri in Jhabua State, Central India, is a fluo-arsenate of magnesium and calcium with the chemical formula (MgF) $CaAsO_4$, a specific gravity of 3·768, a hardness of 3½, and monoclinic crystallisation. It is probably identical

Tilasite

[1] *Mem. Geol. Surv. Ind.*, XXXVII, pp. 216, 219 (1909).

[2] *Nature*, Feb. 17, 1910, p. 477, and June 23, 1910, p. 513.

with tilasite, described in 1895 by H. Sjögren from the famous Swedish manganese mine of Langban, and named after a Swedish mining engineer, D. Tilas. The Swedish mineral differs from the Indian in having a grey colour with a violet tinge. From the Indian material, much of which was generously contributed by Mr. H. J. Winch, it has been found possible to work out the crystallographic characters of the mineral, for which purpose the Swedish material was too imperfect.

The other mineral, that found at the Sitapur manganese mine in the Chhindwara district of the Central Provinces, where it is fairly abundant as a white to pale pink mineral associated with hollandite, braunite, sitaparite, and psilomelane, has proved to be an arsenate and phosphate of both calcium and strontium. It is to be regarded as the arsenic analogue of apatite, with which the Sitapur mineral seems to agree in crystallographic characters, as far as can be judged from the material available, for no really well-crystallised specimens have yet been found. The name fermorite has been proposed for this mineral.

Fermorite.

The occurrence of these two arsenate minerals in the Indian manganese deposits is of considerable interest, for perhaps one of the most striking facts known with regard to the distribution of minerals is the presence of some 20 species of arsenates and antimonates—most of them not found elsewhere—in the Swedish iron-manganese mines of Langban, Pajsberg (Harstig mine), Nordmark (Moss mine), and Jakobsberg, in Wermland, and of Sjö in the province of Orebro. Nearly all of these minerals contain manganese as an essential constituent, but a few of them, including tilasite, are free from this element. In view of the fact that both the Swedish and the Indian deposits in which the arsenates occur are of Archæan age, it is not unlikely that careful scrutiny of the Indian deposits during their exploitation may lead to the discovery in India of other arsenates, and perhaps also of antimonates.

2. Crystals of braunite, of which an account is embodied in a note in *Records, Geol. Surv. India*, Vol. XLI, p. 43, have recently been obtained from some additional localities in the Central Provinces (Thirori, Kachi Dhana, and Satak), and from Gariajhor in Gangpur State, Bengal, the extension into which of the gondite series of the Central Provinces has already been noticed in the General Report for the year 1908.

3. Mr. Tipper made an examination of the minerals occurring in the Sankara mica mine, Nellore district, Madras Presidency. The occurrence of

Samarskite, cyrtolite, allanite.

samarskite in this mine has already been noted. The other minerals identified from the mica-bearing pegmatite are cyrtolite and allanite. The cyrtolite occurs in sheaf-like aggregates of crystals usually terminated by prism faces but sometimes with strongly curved pyramid faces as in the original cyrtolite. This mineral would seem to be a hydrated variety of zircon containing a small percentage of uranium. A determination of the amount of uranium gave 1·66 per cent. U_3O_8. Further traces of the rare earths are present. Microscopic examination shows that the mineral has undergone very considerable alteration.

The allanite is in long crystals, surrounded by brownish altered epidote, and occurs in a rock composed of garnet, mica and little felspar. Bands of this rock are common in this particular locality and are part of the pegmatite mass.

Wolframite.

4. A large series of specimens of wolfram from Burma, collected by Mr. Page, was examined in order to ascertain if any of them could be classed as hübnerite. All, however, proved to be typical wolframite.

Rocks of Central India and Rajputana.

5. Messrs. Heron and Jones were engaged, during the recess, in working out the microscopic characters of the rocks collected by them in Alwar and Gwalior respectively, and Mr. Heron will shortly publish a memoir embodying the results of his work.

Palæontology.

Indian Ostreidæ.

6. Mr. Vredenburg has been engaged on a study of the Indian fossil *Ostreidæ*, based on the collections preserved in the Geological Museum; these include specimens from India and from Central Asia. The first instalment of the work will shortly be published in the *Palæontologia Indica*, and deals with *Ostrea s.s.* including the species provided with a ribbed lower valve and an opercular valve without radial ribs. The species dealt with have been classified in the following groups:—

Group of *Ostrea flabellula*.

O. multicostata Deshayes.
O. angulata J. de C. Sowerby.
O. latimarginata Vredenburg.
O. cubitus Deshayes.

Group of *Ostrea elegans*.

O. Cossmanni Dolfus.
O. Fraasi Mayer-Eymar.
O. gajensis, nov. sp.
O. gajensis, var. *Feddeni*.
O. orissensis, nov. sp.

Group of *Ostrea digitalina*.

O. digitalina Eichwald, var. *Rohlfsi* Fuchs.

Group of *Ostrea fimbriata*.

O. turkestanensis Romanowski.
O. Esterhazyi von Pavay.

All the species occur in Tertiary strata ranging from Lower Ranikot (landenian) to Upper Hinglaj (middle miocene). *Ostrea Cossmanni* (*O. plicata* Vred.) has been found in the Laki stage: *O. multicostata* characterises both the Laki and Khirthar. *Ostrea cubitus* and *O. Fraasi* occur in the Nari; *O. turkestanensis* has been found in the Upper Nari; *O. angulata* occurs in the Nari and Gaj and is succeeded in the uppermost Gaj by its mutation *O. latimarginata*. *O. gajensis* also characterises the Upper Gaj beds; *O. digitalina* occurs in the Lower Hinglaj of Baluchistan and in beds of corresponding age in Burma; *O. orissensis* is found in Upper Tertiary beds in the coastal district of Orissa.

Ostrea digitalina is identical with the Burmese form described by Noetling as *Ostrea promensis*.

The forms classified by Mr. Vredenburg within the group of *Ostrea elegans* are remarkable on account of their gradual evolution, which can be followed through successive geological periods. The eocene and miocene forms *O. Cossmanni* and *O. gajensis* appear perfectly distinct from one another, but the oligocene form *O. Fraasi* constitutes an intermediate mutation closely connected with both species. The group has survived to the present day in the Indian Ocean where it is represented by *Ostrea nigromarginata* Sow., in which the ribs have become almost obsolete, but which agrees with the fossil forms in all other characters.

7. The discovery of marine Cretaceous beds in a railway cutting was reported to Messrs. King and Foote subsequently to their examination of

the country south of the Cauvery river, but they were unable to confirm the correctness of the report. The rocks have been rediscovered by Mr. Allan Campbell and include friable argillaceous sandstones underlying the Cuddalore series. They include fossil bryozoa, and casts of bivalves some of which are probably referable to *Inoceramus Cripsi*. These rocks probably represent a southern continuation of the Arialur rocks that outcrop to the north of the Cauvery delta.

Marine Cretaceous near Tanjore.

8. A memoir on the fossil *Giraffidæ* of India by Dr. G. E. Pilgrim has been completed. The chief feature of this memoir is the prominence which has been given to the exact horizon at which each species occurs. Two new and primitive genera have been founded, *Progiraffa* and *Giraffokeryx* from the Nari and Lower Siwaliks. The discovery of a skull of the species *Hydaspitherium grande* Lydekker proves its generic identity with that of *Helladotherium* of the Pikermi beds. The new generic name of *Indratherium* has been proposed for the large skull obtained by Falconer from the Markanda valley below Nahan. The Upper Siwalik and Middle Siwalik *Giraffa* have been specifically separated and two new species of *Hydaspitherium* have been established.

Siwalik vertebrates.

The collection of fossil vertebrates made during the two last years from the Middle and Upper Siwaliks of the Salt Range has been examined and several new genera and species of mammals have been described in a preliminary notice (*Records, Geol. Surv. India*, XL, 63).

A memoir has been written containing full descriptions of the vertebrate fauna of the Gaj stage of the Bugti Hills and the Punjab. This contains several additions and amendments to the preliminary list which was published in 1909 (*Records, Geol. Surv. India*, XXXVII, 139); these occur especially in the *Rhinocerotidæ*.

9. During the year under review, a large amount of palæontological work was done on behalf of the Geological Survey by Mr. F. R. Cowper Reed in England and Dr. C. Diener in Austria. Mr. Cowper Reed has described the collections of Ordovician and Silurian fossils made from time to time by members of the Department in the Central Himalaya and, in a paper published in the *Records* (Vol. XL, p. 1, 'Pre-Carboniferous Life-Provinces'), has discussed their affinities to faunas of other parts of the world. He has also examined and described a suite of Devonian fossils which include a collection sent to the Geological Survey some

Palæozoic fossils of the Himalaya and Afghanistan.

years ago by Lieutenant Grant from the Baroghil Pass in Chitral, a collection from the Hajigak limestone of Afghanistan, a small number of specimens collected by the late Mr. C. L. Griesbach in Khorasan, others obtained by Messrs. Griesbach and Smith in Byans and a small collection from the base of the Lipak series in Kanaur and Upper Spiti. It is an interesting fact that the facies of all these fossils is essentially European. Mr. Reed's paper is published in *Records, Geol. Surv. India*, Vol. XLI, p. 86.

10. One of the many valuable results of Mr. Middlemiss' work during the last three years in Kashmir has been the discovery of Silurian fossils, hitherto unrecorded from any part of that State. The specimens, which were referred to by Mr. Middlemiss in his paper on the Silurian-Trias Sequence in Kashmir (*Records*, XL, p. 213), were sent to Mr. Cowper Reed who has furnished the following results, which are, however, only provisional. The fossils come from four localities:—

(*a*) Gudramer (lat. 33° 48′: long. 75° 27′):—

Calymene Blumenbachii Brong. *var.*
Illaenus cf. *Thomsoni* Salt.
Acidaspis aff. *deflexa* Lake.
Phacops sp.?
Primitia sp.
Beyrichia sp.
Turrilepas? sp.
Orthis elegantula Dalm.
,, ,, *var.* (cf. *canalis* McCoy).
,, *basalis* Dalm. *var.*
,, *sowerbyana* Dav.
,, *crispa* McCoy.
Orthis calligramma Dalm. *var.*
Scenidium cf. *Lewisi* Dav.
Leptaena rhomboidalis Wilck.
Triplecia insularis Eichw.
Plectambonites aff. *papillosa* Reed.
Strophonella cf. *euglypha* His.
Strophomena cf. *antiquata* Sow.
,, sp.
Trematospira Salteri Dav.?
Rhynchospira Bouchardi Dav.?
Zygospira aff. *pentlandica* Haswell ?

Wilsonia cf. *Wilsoni* Sow.
Rhynchonella (*Camarotœchia*) cf. *nucula* Sow.
,, ,, cf. *borealis* Schl.
Atrypa marginalis Dalm.
Merista or *Meristella* sp.
Nucleospira cf. *pisum* Sow.
Orthoceras cf. *tenuiannulatum* McCoy.
Cyrtoceras sp.
Lindstrœmia cf. *bina* Lonsd.
,, ? sp.

Probable age: Upper Llandovery or Wenlock. *Triplecia insularis* has not hitherto been found above the Upper Llandovery, but there is an absence of many typical Llandovery forms.

(b) Gugaldar (33° 51′: 75° 25′), Harpatnar valley:—
Calymene Blumenbachii Brong. *var.*
Encrinurus cf. *punctatus* Brunn.
Acidaspis aff. *coronata* Salt.
Orthis elegantula Dalm.
,, ,, var. (cf. *canalis* McCoy).
,, *basalis* Dalm. *var.*
,, cf. *canaliculata* Lindstr.
,, aff. *edgelliana* Salt. ms.
,, cf. *crassa* Lindstr.
Plectambonites transversalis Dalm.
Scenidium cf. *Lewisi* Dav.
Merista or *Meristella* sp.
Nucleospira cf. *pisum* Sow.
Alveolites reperus Foug.?
,, ? sp.

Probable age: Wenlock, although the variety of species of Orthis and the absence of a more varied assemblage of fossils are unusual except in the Silurian of Ireland.

(c) Below Margan Pass, S. W. side (33° 44′: 75° 32′):—
Conchidium cf. *Knighti* Sow.?
Orthis sp.

Probable age: Aymestry Limestone, on the strength of the doubtful and poorly preserved example of *Conchidium*.

(*d*) Lutherwan (33° 46′: 75° 35′):—

Calymene Blumenbachii Brong. *var.*
Acidaspis aff. *coronata* Salt.
Encrinurus sp.
Illænus ? sp.
Orthis elegantula Dalm.
,, *basalis* Dalm. *var.*
,, *rustica* Sow.
Scenidium aff. *Lewisi* Dav.
Plectambonites transversalis Dalm.
Leptæna rhomboïdalis Wilck.?
Alveolites repens Fougt ?
Coenites ? sp.

Probable age: Wenlock. The same remarks apply to this assemblage as to that from locality (*b*).

Anthracolithic fossils of the Shan States.

11. During the course of their surveys of the Northern and Southern Shan States respectively, Messrs. La Touche and Middlemiss obtained a considerable number of fossils of Upper Palæozoic age. These were sent to Dr. Diener for examination; his description of them is now in the press and will shortly be published in the *Palæontologia Indica*.

The fossils, which are derived from Kehsi Mansam and Namun in the Northern Shan States and from between Hopong and Möngpawn in the Southern, are regarded by Dr. Diener as equivalent in age to those of the Upper and Middle Productus Limestone of the Salt Range and the exotic block of Chitichun No. 1 in Tibet. Out of 47 species considered to be specifically determinable, 30 are either identical with or very closely allied to Salt Range forms. In each of the three localities the brachiopods form the most important section of the fauna, but at Namun the prevalence of *Bryozoa* also is very marked. The only trilobite, *Phillipsia sp. ind. aff. Middlemissii* Diener, was collected by Mr. Middlemiss in the Hopong area, whilst *Fusulina elongata* Shumard is abundant at Kehsi Mansam. The latter fossil is of interest since it also occurs in considerable quantity in the Fusulina limestone of Bamian in Afghanistan.

Himalayan Trias.

12. Dr. Diener has also completed a memoir on the distribution and development of the Trias of the Himalaya. This work originated from a paper which was

being prepared at the time of his death by the late Dr. von Krafft, whose wide experience of both Alpine and Himalayan stratigraphical geology rendered him peculiarly fitted for the task. His notes on the subject were eventually forwarded to Dr. Diener, who has incorporated them in his paper, which will shortly be issued as *Memoirs, Geol. Surv. India*, Vol. XXXVI, pt. 3.

Fauna of the Spiti Shales.

13. The work of Professor Uhlig, on the ammonites of the Spiti Shales, which has extended over so many years, has now been finally completed and the last part ("Geological Results") has recently been received from the author. This will be translated by Mr. E. Vredenburg, who has devoted much time and care to the revision and editing of the later fasciculi.

The fauna of the Spiti Shales, so far as it is known at present, includes 218 species of ammonites, 4 of belemnites, 35 of lamellibranchs and two of gastropods. The lamellibranchs and gastropods have been described by Dr. Holdhaus, whose work has been translated by Mr. Vredenburg. From a study of the fauna, Dr. Uhlig has come to the conclusion that the various zones of the Spiti Shales extend from the Oxfordian to the Valanginian, both inclusive. The lower beds contain only a scanty fauna, the commonest fossil being *Belemnites Gerardi*. The bulk of the fauna is contained in the middle and upper subdivisions. The middle Spiti Shales or Chidamu beds appear to contain the equivalents of the Kimmeridge and lower tithonian, while the infra-valanginian (berriasian) and valanginian proper are undoubtedly represented in the Upper Spiti Shales or Lochambel beds which contain also upper tithonian fossil types.

The exact zonal distribution of the Spiti Shales fauna has not been fully worked out in the field; the detail of the subdivisions is difficult to follow owing to the lithological uniformity of the formation. Nevertheless, the abundance of fossils in the upper horizons may ultimately enable this research to be successfully carried out.

From the character of the fauna and of the deposit, Dr. Uhlig concludes that the Spiti Shales were deposited in rather deep water at a distance from the coast. Rocks of similar character and with the same fossils have been described from the Sula Islands in the Dutch Indies. The Himalayan facies of the Upper Jurassic and lowermost Cretaceous shows very little similarity to that of the Russo-boreal region, being much more nearly related to the fauna of same age in the Mediterranean region.

14. The fossils collected at various times from the Giumal Sandstone of the Himalaya have been worked out by Dr. Albrecht Spitz, who regards the Giumal Sandstone as ranging in age from middle neocomian to the base of the Upper Cretaceous.

Fauna of the Giumal Sandstone.

ECONOMIC ENQUIRIES.

Coal.

15. During the field-season of 1909-10, I visited the Saffrai and Taukak valleys with a view to examining the coal outcrops that had not already been reported on by Mr. R. R. Simpson.[1] As the results of my investigations have already been published in the *Records* (Vol. XL, p. 283), they need not be further referred to here.

Assam.

16. Throughout the greater part of the year, Mr. H. Walker was still engaged in a survey of the Raniganj Coalfield in connection with the large-scale map now under preparation by the Mining and Geological Institute of India, but before completion of the office work in connection with this, he was unfortunately compelled to take sick leave, and the map still remains unfinished. It is hoped that Mr. Walker will be able to complete his share of the work soon after his return from leave.

Bengal.

17. Mr. M. Stuart examined certain localities in Henzada district where coal-seams were reported to occur. The chief outcrops are at Posngyi, Kywezin, Hlemauk and Kyibin. Of these Kywezin seems to be the only area worth further attention; the coal there is very friable and greatly crushed, whilst the seam, which is about 10 feet thick, is much contorted. The composition of the coal, however, is good.

Burma.

18. The experimental boring at Dandot referred to in the last General Report (p. 53), was completed by Messrs. Kilburn & Co. in October, and coal was found at a depth of 309 feet from the surface. The seam, however, was only 1 foot 10 inches thick. Much difficulty was experienced in sinking the boring, owing chiefly to the cavernous nature of the nummulitic limestone and to the extreme softness of the intervening shales; so great was this difficulty that one hole had to be abandoned at a depth of 256 feet.

Punjab.
Dandot boring.

[1] *Rec., Geol. Surv. India*, XXXIV, 199.

It is now proposed to put down further borings in the neighbourhood of Tothral and Dalelpur in order to test the coal-measures below the nummulitic limestone towards the centre of the Dilwal plateau.

Engineering Questions.

19. At the request of the respective Local Governments, Mr. H. C. Jones was deputed to examine and report on proposed sites for dams at Ghori Gali, Pind Swika and Rhotas in the Jhelam district, Namal in the Mianwali district, Punjab, and near Nainpur in Mandla district, Central Provinces. His reports were forwarded to the local authorities concerned.

Galena.

Gwalior State: Mr. Jones.

20. In the course of his survey of the Gwalior State, Mr. H. C. Jones examined a deposit of galena occurring at Aindhar (lat. 25° 32′: long. 78° 8′). The galena occurs in small veinlets, patches and streaks, together with quartz and barytes, in a 5 ft. band in the gneiss, which apparently runs parallel to a quartz vein. Four pits had already been sunk somewhat irregularly at the N. E. end of the band and a considerable amount of the ore proved. Mr. Jones suggested fresh localities for further trial pits and for a tunnel in the area S. W. of the pits already opened with the object of proving the band over a longer line of outcrop. He also made some suggestions as to leasing and smelting.

Iron-ore.

Chanda, Central Provinces.

21. Near the small village of Poser (19° 56′: 80° 12′), the Archæan gneisses contain a band of hematite, which has been traced by Mr. P. N. Datta for a distance of 275 yards with an average thickness of about 20 feet and high dip to S. by E. The ore is almost theoretically pure hematite, and contains 69·8 per cent. Fe. Mr. Datta was unfortunately unable to determine the extent of the ore-body.

Iron-ore was also observed in the quartz hills to the south-east of Chamoursi (19° 56′: 99° 57′) and in the range running from near Wingnur (90° 46′: 80° 15′) to Emagarh (19° 42′: 80° 33′), but the amount available is unknown.

Kirana Hills: Mr. Heron.

22. During a visit to the Kirana Hills, Mr. Heron took the opportunity of examining the iron and manganese-ores said to occur there in some quantity. Mr. Heron, however, found only traces of manganese, whilst the iron-

ore proved to be of very poor quantity. Smelting, which was carried on on a small scale in the past, seems now to have been discontinued.

Monazite.

23. In consequence of the discovery of monazite sand in Travancore, Mr. G. H. Tipper was deputed to examine the coastal regions of that State on behalf of the Durbar. He found that certain beaches, chiefly along the west coast, were very rich in monazite, and consisted, in fact, of natural concentrates produced by the mechanical sorting action of the waves. Between Quilon and a point a few miles to the north-east of Cape Comorin, Mr. Tipper examined some seven deposits, in one of which he estimated that there must be at least 18,000 tons of pure monazite.

The mineral has also been found *in situ* in pegmatite near Thadikarenkonam, 14 miles north-west of Nagarcoil, and in the form of felspar-monazite rock, associated with graphite, in the leptynites and charnockites of Travancore.

Petroleum.

24. Mr. E. H. Pascoe paid a flying visit to Digboi early in the year, with a view to drawing up a programme for a subsequent survey of the oil-bearing regions of Assam. For the rest of the year he was engaged on a memoir on the Burma oil-fields; this is now in the press and will shortly be ready for issue.

Assam.

25. During the field-season 1909-10, the following surveys were made by the Burma Oil-fields party:

Burma.

In addition to the examination of Kyaudaw Island in Magwe and an area round Nyaungbintha village in Thayetmyo, Mr. Cotter carried out surveys of the areas comprised in the following sheets (1″=1 mile):—

(*a*) sheet 112 complete, with a small portion of the Minbu district in the south-western part of sheet 158 and a part of sheet 113 on the Pegu-eocene boundary;

(*b*) part of sheet 110, to the east of the Irrawadi;

(*c*) sheet 84-K-16 complete, with the exception of the western boundary of the Yenangyat anticline, which was mapped by Sub-Assistant Sethu Rama Rau.

The first of these areas lies in the Minbu district, and its survey has thrown a considerable amount of light on the relations between the Pegu and eocene series of this part of Burma. A section in the Kyetsu chaung shows that the Pegu beds form a sharply folded anticline, the dips on either side of which are approximately the same. The Pegu outcrops widen towards the south. Gas-pools occur to the south of the Kyetsu chaung, and four holes with bubbling mud were noticed in the same locality. There was, however, no sign of oil.

The second area (part of sheet 110 to the east of the Irrawadi) is covered by Plateau Gravel, Red Earth and Irrawadi beds.

Sheet 84-K-16 comprises the Pagan hills, which consist of sandstone and shale bent into a faulted anticline similar to that of Yenangyat. These, together with the Gwegyo hills and the Payagyigon-Ngashandaung anticline may be regarded as different wave-fronts of a single anticlinal fold. Fragments of the crest are seen on the north and on the south of the Naletaw chaung. The crest-line is not continuous, but is broken by dislocation and faulting, and the rocks are often contorted. The curve of the anticline is very similar to that of Yenangyat, except that the beds on the west always dip more steeply than those on the west of the crest in the latter field. To the south the westerly-dipping Pegu beds are faulted against Irrawadi sandstone.

26. Mr. K. A. K. Hallowes was engaged in mapping the country shown on sheets 154 and 201 of the Burma Survey (1″ = 1 mile). The rocks comprised in this area include Red alluvium, members of the Irrawadi and Pegu series and a volcanic series of late Tertiary and post-Tertiary age. Tuffs, indicating the presence of an older volcanic group, were found interbedded with the Pegu sandstones of the Kyaukaingma anticline. The junction between the Irrawadi and Pegu series is said to be an unconformable one.

No oil-shows were found in this area, which is not regarded as of economic importance.

27. During the course of a survey of the Henzada district, Mr. M. Stuart examined various areas where oil was supposed to occur. He found nothing, however, which offered prospects of the discovery of an oil-field in this district.

28. Sub-Assistant Sethu Rama Rau mapped the area included in sheets (Burma Survey, 1″ = 1 mile) 155 and $84\frac{K}{11}$ together with parts of 154, 112, $84\frac{K}{15}$, $84\frac{K}{12}$ and $84\frac{L}{9}$. Sheet 155 comprises three distinct anticlines, the Wetmasut, Yedwet-Wetchok and the Gwegon-Pongon.

The first of these, which lies midway between Yenangyaung and Ondwe, appears to be a narrow fold with steep dips; the crest is formed by beds of doubtful age, which are perhaps uppermost Pegu. Although certain considerations tend to discount the value of this anticline as a source of oil, the general conditions point to it as being worth testing.

The Yedwet-Wetchok anticline has already been described by Mr. E. H. Pascoe (*Records*, Vol. XXXVI, p. 286).

29. The Gwegon-Pougon anticline is merely the continuation of the Kabat fold, and its prospects as an oil-field are similar to those of Kabat.

30. After completing sheet 155, Sub-Assistant Sethu Rama Rau undertook the mapping of the boundary between the Irrawadi and Pegu systems along the western edge of the Yenangyat oil-field. In conformity with Grimes' original classification (*Memoirs, Geol. Surv. India*, XXXVIII, 43), the "Red Bed" was adopted as the basal bed of the Irrawadi system and the white sand as the uppermost division of the Pegu. The Red Bed has yielded various fossils, including vertebrate remains, whilst higher up in the series, near Tabingyaung, a calcareous zone, containing numerous Upper Siwalik forms, was traced for a considerable distance.

Opportunity was taken to measure the whole thickness of the Irrawadi system, which was found to be approximately 8,500 feet, as against Dr. Noetling's estimate of 20,000 feet. The fossiliferous calcareous band occurs at 8,000 feet above the Red Bed.

31. During the latter part of the field-season of 1909-10, Sub-Assistant Sethu Rama Rau examined and collected fossils from the neighbourhood of Payaywa and the Man chaung near Ngape in Minbu district. At the village of Pinnebin, there is a coal-seam from 15 to 20 feet thick, overlain by a petroliferous sandstone. The coal is of poor quality, and often passes into carbonaceous shale; it does not appear to be of any economic value.

Salt.

Salt Range and Sambhar: Dr. W. A. K. Christie.

32. A preliminary enquiry was made by Dr. W. A. K. Christie into the occurrence of salts of potassium in the rock-salt beds of the Punjab Salt Range. Two seams struck in the Mayo mine at Khewra and one in the small mine at Nurpur are promising enough to justify more extended prospecting operations, which it is proposed to carry out during the next field-season.

The Sambhar Salt Lake investigation was proceeded with on the system, adopted in the year 1907, by which 30 samples of lake and subterranean brine from different parts of the Lake are collected each year. Analysis of these has so far shown no definite depreciation in the composition of the brine as a result of salt manufacture.

Samarskite.

Nellore: Mr. G. H. Tipper.

33. The discovery of samarskite in India has already been recorded (*Records*, XXXVIII, 342), but until recently no opportunity had arisen of making a detailed investigation into its mode of occurrence. Owing to a request from the Madras Government for information on the subject, Mr. G. H. Tipper was deputed to Nellore for this purpose on December 20th; his enquiries should be completed early in 1911.

Tin.

Burma: Mr. J. J. A. Page.

34. Mr. J. J. A. Page paid a flying visit to Mawchi in Bawlake State, Karenni, in order to examine the tin mines of Kehdaung. The route chosen lay up the Salween from Tavoy, and, owing to lateness of the season and difficulties of transport, the journey was a most arduous one. Mr. Page found the rocks along the route to consist of various sedimentary types, including limestones, sandstones, slates and conglomerates, referable partly to the Mergui and partly to the Maulmain series. Granite and crystalline rocks are also prominent, and are pierced by quartz-veins containing wolfram and cassiterite. The latter mineral also occurs in the granites. At Keh daung (=tin hill) the quartz-veins appear to be the only important mineral occurrence.

Trona.

Lonar Lake: Mr. T. D. La Touche and Dr. W. A. K. Christie.

35. An investigation was made by Messrs. La Touche and Christie into the origin and the resources of the Lonar Lake in the Buldana district of Berar. This curious crateriform hollow measures about a mile and a quarter from crest to crest of its slightly raised rim, and on its muddy bottom, some 250 feet below the level of the surrounding Deccan trap country, is a shallow sheet of brine, from which urao (trona), a hydrated compound of carbonate and bicarbonate of soda, had been profitably recovered for many years. Stress of outside competition has, however, rendered the impure products obtained from the lake by simple

evaporation almost unsaleable, and the enquiry was undertaken with a view to determining what the economic possibilities of the deposit really were.

The resources of the basin, in so far as they could be ascertained without borings, have been determined and in a report now in the press suggestions have been made for their more efficient realisation. The vexed question of the geological structure of the neighbourhood, important on account of this being the only instance of late volcanic activity—if it really were such—in the Peninsula, has been fully discussed by Mr. La Touche, who, rejecting the theory of volcanic explosion suggested by Dr. W. T. Blanford and supported by Mr. R. D. Oldham, considers it to be due to a sudden inrush of vapour or molten rock from below through fissures that did not penetrate to the surface, the central part of the "blister" thereby formed afterwards collapsing into the hollow beneath, when a lateral fissure had allowed of the escape of the imprisoned gas or lava. The origin of the salts in the lake basin has also been discussed, the analytical data affording corroboration of Blanford's theory that the deposit is due simply to evaporation of the stream water in the absence of an exit.

Water.

36. In addition to the usual large number of references, both from officers serving under the various Local Governments as well as from private individuals, on the subject of the prospects of artesian and other borings, special investigations were made into the conditions prevailing in various parts of Gujarat and Broach in the Bombay Presidency, and also at Ongole in Madras.

Gujarat.

In Gujarat, the scarcity of potable water has led to an attempt being made to obtain a sufficient supply either from artesian sources or from deep borings in the alluvium. It was originally suggested by the Geological Survey that trial borings should be put down in the neighbourhood of Wadhwan, but, owing to various considerations, sites were eventually chosen, by the local authorities, at Dholka and Sanand. A Calyx drill belonging to the Geological Survey was lent for the purpose, and borings were sunk into the alluvium; water was found at depths of 304 feet and 200 feet respectively at Sanand and Dholka. The borings were not carried through the alluvium, and the water was consequently not under artesian conditions. Although the water obtained at Sanand was finally found not to be potable, the experiments conducted by the Local Government are

regarded as decidedly promising since they indicate the presence of water in considerable quantities at no great depth below the surface.

Broach: Mr. H. Walker.

37. Mr. H. Walker, who was deputed to examine various sites in Gujarat, came to the conclusion that there is a greater probability of obtaining water from deep borings in the alluvium than from artesian sources in the Tertiary and Mesozoic rocks underlying it. At Broach, on the other hand, he is of opinion that an artesian supply may be obtained from the Tertiary sandstones and grits which crop out to the south-east and, dipping towards the north-west at angles varying from between 30° and 40° to between 5° and 10°, pass under the Nerbudda alluvium on which the town stands. Mr. Walker recommends that, if necessary, a boring should be carried to a depth of 2,000 feet. He does not expect that the artesian conditions will be sufficiently perfect to cause the water to flow at the surface, and a certain amount of pumping would probably be necessary.

Ongole: Mr. G. K. Tipper.

38. With a view to devising a scheme for increasing the water-supply of the town of Ongole, Mr. G. H. Tipper was deputed to make a detailed examination of the neighbourhood. He found that the local conditions were unpromising. The town lies, at a considerable distance from rivers of any size, on the northern slopes of a small range of hills composed of hornblende-schist, the foliation planes of which dip towards the south. The range is surrounded by a narrow strip of lateritic gravel of no great depth or extent, while the adjoining plains are composed of cotton soil. The present water-supply is derived from wells which have been sunk, in some cases through solid rock, in others through gravel and the decomposed gneiss underlying it. The latter wells are naturally the chief sources of supply.

Three schemes were under consideration:—

(*a*) a boring at about 1½ miles to the west of the town with a view to finding water under artesian conditions in the local representatives of the Gondwana system;

(*b*) utilisation of rivers;

(*c*) a filtration gallery on a line of wells near the town.

The first of these was rejected on the ground that any water in the Gondwanas would not be under sufficient pressure to rise to the surface, whilst the cost of the second was considered prohibitive owing to the great distance to the nearest river of any size. The third scheme, which had been

proposed by the Sanitary Engineer, Madras, although not regarded as completely satisfactory, was recommended as the only practicable method of increasing the water-supply.

Wolfram.

39. A report has been submitted by Mr. J. J. A. Page on the wolfram of Mawchi in the Bawlake State, Karenni. This has already been dealt with under *Tin*, *q.v.*

GEOLOGICAL SURVEYS.

Assam.

40. During the field-season of 1909-10, I examined a considerable area of hitherto unsurveyed territory in the Naga Hills between Kohima and the Disang river. The only rocks met with were members of the Disang, Tipam and Dihing series. Fossils, including an ammonite, were found for the first time in the Disang shales, and although they were unfortunately not determinable, they indicate that this series is at least in part pre-Tertiary. The question has been dealt with in a paper published in the *Records*, Vol. XL, p. 283.

Burma.

41. Mr. Stuart was engaged throughout the field-season in mapping the Henzada district. In the General Report for 1909, attention was drawn to the fact that Mr. Stuart had observed an unconformity in Western Prome between the Kama clay and the overlying marine beds which had always been regarded as the upper part of the Pegu system. These marine beds Mr. Stuart included in the Irrawadi system under the name "Marine Irrawadi." In order to avoid confusing established nomenclature by an attempt to change the significance of the term "Irrawadi system," he has now adopted the name "Akauktaung series" for these marine beds, which he has found also in Henzada, where they are said to overlap the whole of the Upper and Lower Prome series and to rest directly on the Silsayun shales. He regards them as of middle miocene age.

Henzada District: Mr. M. Stuart.

Central India and Rajputana.

42. Mr. Jones continued his revision of the geology, and his investigation of the minerals, of the Gwalior State in those parts which lie to the west and south of the area begun last season (General Report for 1909-10, p. 69).

Gwalior: Mr. H. C. Jones.

The re-examined area lies between latitudes 24° 48′ and 26° 40′ and longitudes 77° 40′ and 78° 30′. The rock groups do not differ from those summarised in last year's General Report and are:—

(1) Bundelkhand gneiss with quartz reefs and dolerite dykes,

(2) Upper Vindhyan sandstones and shales, lying unconformably above the gneisses and also above the Gwalior representatives of the Bijawars,

(3) Laterite, and

(4) Alluvium.

43. In his progress report Mr. Jones remarks on the general geology of the area being very similar to that of the area surveyed the season before. As before, also, he does not find anything to dispute in the original mapping of it as carried out by Messrs. Hacket and Kishen Singh, with the trifling exception of a few laterite hills which he found to be sandstone, in the Vindhyan area. He has, therefore, submitted no new maps, and the bulk of his report is descriptive of local occurrences of the rock systems mentioned above.

44. With the exception of some galena at Aindhar, which has already been referred to, nothing of special economic interest was observed.

Alwar: Mr. A. M. Heron.

45. Except for a few weeks spent in investigating the effects of the Baluchistan earthquake and a passing examination of the Kirana hills, Punjab, Mr. Heron was engaged the whole season in continuing his work in Alwar State, the re-survey of which is now almost finished. As Mr. Heron proposes putting his results in memoir form at an early date, it will be sufficient here to note that his matured conclusions, after a second season, agree with his views briefly outlined in the last General Report (p. 71), as to the true sequence of the formations, which in the main follow Hacket's original scheme as opposed to his (Hacket's) later interpretation of them.

At the same time there are many minor differences between the new and the old survey, and a much greater accuracy of delineation of the geology as displayed in Mr. Heron's new mapping, which, together with his photographs, sections, and detailed petrological studies, should afford material for a full descriptive account of this complicated region, whose geological interpretation has long remained uncertain.

Banswara: Mr. Daru.

46. Mr. Daru continued his survey of Banswara, which he practically completed, by filling in the remaining blanks on sheets 176, 176 and 177 of the Central India

and Rajputana survey left over from last year, and with the addition of about 50 square miles in sheet 178.

Alluvium, Deccan Trap, Aravalli series and crystalline rocks continue as before throughout the region, and Mr. Daru's results may be briefly stated to be an extension into the new area of the mapping of the rock groups already begun by him.

The stratigraphical order of the members of the Aravalli series among themselves, tentatively adopted by Mr. Daru (see General Report for 1909-10, p. 73), has, however, been finally rejected by him. He finds that limestones and even conglomerates have been intercalated at various horizons between the slates, etc., though a conglomerate band has often been found next to the supposed older crystalline rocks.

47. With regard to the problem of the intercalations of those crystalline rocks and the Aravallis referred to in last year's General Report, he now writes:—

> "Although, in this report, following the arrangement of my preceding report, the crystalline intrusives and gneisses are placed as if belonging to an age prior to that of the Aravallis, the validity of such a course is open to dispute, especially with respect to this season's work. Intrusion has undoubtedly taken place into the Aravalli rocks, the intrusives have at times taken on gneissic characteristics, and have yielded boulders for the Aravalli boulder-beds; and these intrusives and gneisses are indistinguishable from those occupying larger but comparatively insignificant areas. Probably, therefore, the Aravallis and the intrusives and gneisses seen this season are coeval; some of the latter are undoubtedly subsequent to the Aravallis as can be seen from the way these have been disturbed. The same might, but with much less certainty, be said of the quartz-veins forming such a conspicuous feature of the Aravallis."

Central Provinces.

Chanda district: Mr. P. N. Datta.

48. The previously unsurveyed portion of Chanda district shown on Atlas sheet No. 73 was mapped geologically. It was found to consist chiefly of crystalline rocks, with a small patch of Vindhyans (conglomerate, sandstone, shale and limestone) in the extreme south-western corner. A red sandstone occurring at Markhunda on the left bank of the

Wainganga is regarded as possibly of Gondwana age. The crystalline rocks comprise three groups:—

(*a*) a series of quartz, mica and hornblende-schists, with gneiss and argillite;

(*b*) gneissose granite; and

(*c*) diabase, granite and quartz.

The schistose gneisses (*a*) are regarded as older than either (*b*) or (*c*). They contain a bed of hematite which may be of economic value.

Punjab.

Kangra district: Dr. G. E. Pilgrim and Sub-Assistant Vinayak Rao.

49. Dr. G. E. Pilgrim has been engaged on a general geological survey of the Sub-Himalayan Tertiary zone between the river Ravi and Subathu, included for the most part in the districts of Kangra and Hoshiarpur, in the State of Chamba, and the Simla Hill States. He was accompanied during part of the time by Sub-Assistant M. Vinayak Rao, to whom was entrusted a portion of the mapping, and on whose work Dr. Pilgrim reports favourably.

Speaking broadly, the general geological and structural features follow those indicated by Medlicott on the map accompanying his memoir on this region (*Mem., Geol. Surv. India*, III, pt. 2). A few modifications, however, have been found advisable. Medlicott omitted to differentiate between the Nahans (Lower Siwaliks) and the Siwaliks (Upper and Middle Siwaliks) to the north-west of the Sutlej, except along the innermost zone. It has now been found possible to separate the Nahans as far as the river Ravi, but, in the middle portion of this area lying between the river Beas and a line joining Una (31° 29′: 76° 20′) to Mandi (31° 43′: 76° 59′), only Upper and Middle Siwaliks are exposed from the Nahan boundary fault mapped by Medlicott right down to the plains. This absence of lower beds is due to the fact that the axes of the various folds dip both from the north-west as well as from the south-east towards this middle portion. As a result the upper beds have been removed by denudation from off the country to the north-west and south-west, thus exposing to view the older beds. The upper boundary of the Nahans (Lower Siwalik) is appropriately fixed by some very constant and very characteristic bands of red calcareous nodular clay, below which the sandstones are harder and, with the exception of a slightly pebbly zone much lower down in the series, contain no pebbles. This zone of red

nodular clays is considered to belong to the uppermost part of the Lower Siwaliks; the fossils found in it—*Dinotherium*, *Amphicyon palæindicus*, *Giraffa*, *Dorcatherium*, *Hipparion* and *Hemimeryx pusillus* (?)—seem to point to a fauna which is more closely related to the Lower Siwaliks of Sind and Chenji in the Salt Range than to that of the typical Middle Siwaliks of the Salt Range. These nodular clays are very similar in appearance to those which are found in the Lower Siwaliks of the Salt Range. At Nurpur, certain pisolitic, pyritous beds associated with the red nodular clays resemble so closely the Lower Siwalik beds of the Kalawala Rau in the Siwalik Hills to the north of Saharanpur as to lead Dr. Pilgrim to correlate the two. At the same time, there is little doubt that they represent a higher horizon than the Chenji one, and must be put at the very top of the Lower Siwaliks. The fauna, when more fully known, will probably prove to be intermediate between that of the typical Lower Siwaliks of Chenji and that of the typical Middle Siwaliks of Dhok Pathan and Asnot.

50. The lowest member of Medlicott's Sirmur series, the Subathu, *sensu stricto*, is easily separated from the Dagshai-Kasauli group. Its fossils prove it to be of Khirthar age, and Dr. Pilgrim considers that stratigraphically as well as palæontologically, a great unconformity exists above this horizon.

51. There seems to be considerable probability that the Dagshai-Kasauli series passes up conformably into the Nahans. What Medlicott suggests to be an intermediate group (*Mem. Geol. Surv. India*, III, pt. 2, pp. 132, 133), though mapping it for the most part, but not universally, as Nahan, occurs along the base of the Nahan outcrop between Naini Devi (31° 18′ : 76° 36′) and Pinjor (30° 44′ : 76° 58′). Since these beds can be readily separated from the Nahans by their characteristic purple colour and by the greater hardness of the sandstones, while, on the contrary, their separation from the Dagshai-Kasauli group is a matter of extreme difficulty, it will most probably be found convenient to unite them with the latter series.

52. The pebbly sandstones above the Nahan nodular clays contain, north of Babhor (31° 24′ : 76° 26′), *Mastodon sivalensis*; they are harder than the typical Upper Siwaliks of the Pabbi Hills and elsewhere, and it is probable that a portion of the group above the red nodular clays represents the fossiliferous Middle Siwaliks of the Salt Range area. The thickness of this portion probably varies from some 500 feet to 5,000 feet. It is, however, a matter of extreme difficulty to fix the boundary between it and the Upper Siwaliks; the position of such boundary can

only be very approximate, and is based on the harder nature of the sandstones and on the occurrence of somewhat concretionary beds and calcareous bands. The Upper Siwaliks are often fossiliferous down to some 3,000 feet below the top. Near Pinjor (30° 44′ : 76° 58′) and between that place and Rupar (30° 58′ : 76° 36′), remains of the characteristic genera occur, amongst them being *Equus*, *Bos*, *Camelus*, *Elephas*, *Sivatherium* and *Merycopotamus*.

53. The so-called "Belaspur conglomerate," mapped by Medlicott as Nahan, is regarded by Dr. Pilgrim as Upper Siwalik, while the sandstone overlying it he believes to be Middle Siwalik. He also assigns an Upper Siwalik age to the thick beds of conglomerate which are met with at various places along the inner boundary of the Tertiary, faulted against the metamorphic beds. This conglomerate occurs in the hills below Dalhousie and continues almost as far as Dharmsala; it is seen again between Mandi and Baijnath. In all these cases it has been mapped by Medlicott as Nahan.

54. The "Barsar" fault and the Nurpur fault are not on the same line of dislocation. The former fault has not been traced by Dr. Pilgrim appreciably farther to the north-west than the river Beas. The latter, which he regards as a branch of the "Gamber" fault, arises some little way to the north-west of Juwalamukhi (31° 53′ : 76° 23′). It seems to be cut off to the south-west by a cross fault which runs from Deira Gopipur through the Juwalamukhi range and probably extends past the so-called "Puthiar promontory" near the Neogal river. The fault mapped by Medlicott to the south-west of the Naini Devi range appears really to take its rise immediately east of Naini Devi (31° 18′ : 76° 36′) and to continue as a boundary fault between the Upper Siwaliks and the purple intermediate beds mapped by Medlicott as Nahan, but which Dr. Pilgrim prefers to include with the Dagshai-Kasauli series. This fault continues to the hills below Nahan, though often obscured by post-Tertiary deposits. The structure of the Naini Devi and Sola Singhi ridges was regarded by Medlicott as that of a syncline, but is regarded by Dr. Pilgrim rather as that of a much folded anticline.

Kashmir: Mr. C. S. Middlemiss.

55. During the summer, Mr. Middlemiss continued his revision of the survey of Kashmir, and by detailed examination of the Sind valley up to the Zoji La and of parts of the Pir Panjal, added still further to the already large stock of valuable scientific information acquired by him during the last few years. Mr. Middlemiss' work shows that Lydekker's interpretation of the age and structure of the Pir Panjal requires modification in many

important respects, the most striking new fact being the absence of any pre-Carboniferous rocks and the continuation of the Lower Gondwana and Triassic beds along the north-eastern slopes of the range from Gulmarg to the Golabgarh Pass, where they cross the crest. The range is therefore composed of members of the Carbon-Trias sequence and constitutes a separate tectonic element, distinct, on the one hand, from the younger Sub-Himalayan and Nummulitic zone to the south-west and, on the other, from the older zone or zones, to the north-east, comprising large areas of rocks of pre-Carboniferous age.

Mr. Middlemiss' results are published in *Records, Geol. Surv. India*, Vol. XLI.

56. During the field-season of 1909-10, Mr. A. M. Heron visited the small groups of hills of the Jech and Rechna Doabs.

Kirana Hills: Mr. A. M. Heron.

There are in all four groups, *viz.*, at Kirana, at Chiniot, at Sangla, and at Shahkot. These hills are of peculiar interest as being at only a comparatively short distance from the fossiliferous belt of the Salt Range, to which, however, they appear to bear no stratigraphical or lithological resemblance. According to Mr. Heron, they consist of highly altered slates and quartzites, which stand almost vertical and strike from N. W. to S. E. On the southern part of the Kirana Hills, there are numerous bands of diabase and dark chert-like rocks. The general facies of the whole series of exposures is said to be somewhat similar to that of the Alwar and Ajabgarh divisions of the Delhi series.

GEODESY.

BY

J. ECCLES, M.A.,
Superintendent, Trigonometrical Surveys.

PRINCIPAL TRIANGULATION.

Operations during the cold weather season of 1910-11 and the hot weather season of 1911 were carried on in the following provinces:—

(1) Burma (Myitkyina district and the Southern Shan States).
(2) Kashmir.
(3) Central India.

(1) Burma.

(a) Myitkyina district. The Upper Irrawaddy Series.

Lieutenant Cardew continued this series from the side Marau H. S.—Matu Bum H. S. on which last year's work closed.

He commenced operations on November 6th, 1910, and completed observations at eight stations, closing work on the 30th March 1911. He extended the series, 100 miles in a westerly direction, by means of three quadrilaterals.

Lieutenant Cardew had hoped to close his work on the Mandalay Meridional Series, but the difficulty of clearing the dense forests on the hills delayed the work to such an extent, that the last figure had to be left unobserved.

The ten completed triangles have an average triangular error of $0''{\cdot}875$ and the triangulation covers an area of 1,760 square miles.

In addition to the triangulation work, Lieutenant Cardew observed an astronomical azimuth at Kumon Bum. The value of this azimuth differs from the geodetic value by $7''{\cdot}02$.

The observations at all stations were taken with a two-microscope $12''$ theodolite.

(b) Southern Shan States. The Great Salween Series.

This series emanates from the side Ubyetaung—Katha of the Mandalay Meridional Series, on meridian 96°. It runs thence due

east, between the parallels 23° and 24°, till it reaches the Salween river which it then follows in a southerly direction to parallel 22°. It then again bends eastward till it meets the eastern frontier of Burma, along which it is proposed to continue the series.

The work had closed in March 1909 at a point midway between the Salween river and the eastern boundary of Burma.

It took six weeks for the detachment to march from Thazi on the railway to Loi Lung, the first station of observation, and observations were therefore not commenced till December 7th.

Lieutenant King, R.E., who was in charge of the detachment, took observations at five stations.

Thick haze set in on the 19th February rendering the continuation of the triangulation impossible. The haze cleared sufficiently towards the end of the month to enable Lieutenant King to observe an azimuth at Hsam-Hsum by means of a referring mark set up a few miles away from the station. On completion of this azimuth the work was closed.

Lieutenant King extended the series about 74 miles in a south-easterly direction by means of one quadrilateral and one tetragon. The nine completed triangles have an average triangular error of 0″·753 and the triangulation covers an area of 2,200 square miles.

The value of the astronomical azimuth observed differs from the geodetic value by 7″·35.

The observations at all stations were taken with a two-microscope 12″ theodolite.

(2) Kashmir.

(a) *The New Kashmir Principal Series.*

Owing to the heavy winter experienced in Kashmir in 1910-11, the commencement of operations on this series was somewhat delayed.

Lieutenant Bell, R.E., who has been the observer this year, continued the series from the side Rutha Pahar H. S.—Chotiwala H. S. on which Mr. Hunter closed his work last year.

Lieutenant Bell began his observing work at Liowi on the 14th June 1911, and by the 25th July had completed observations at four stations. The heights of these average about 16,000 ft., the highest being Liowi 17,480 ft.

The series has been extended some 60 miles in a northerly direction by means of two quadrilaterals to parallel 35°·45′. The eight completed

triangles have an average triangular error of 0″·69 and the triangulation covers an area of 730 square miles.

The observations at all stations were taken with a two-microscope 12″ theodolite during this season. At the end of last season, owing to the difficulties experienced in transporting the 12″ theodolite to the top of Chotiwala H. S. it was considered advisable to use an 8″ theodolite. The forward rays from this station were consequently observed with this instrument. The loss of accuracy is shown by the fact that there are two triangles, which include the angles at this station, in each of which the triangular error exceeds one second.

Lieutenant Bell and Mr. Wainright, the latter of whom had been employed on building forward stations, have now started to reconnoitre the country north of Gilgit, in order to decide whether it will be feasible to carry the triangulation on and finally connect up with the Russian triangulation on the Pamirs. Lieutenant Bell has visited the Darkot Pass and has reported that the peaks of the Sakis Jarab range are inaccessible.

(b) *Teram Kangri.*

Mr. Collins assisted by Mr. Wyatt started from Srinagar in May for the purpose of definitely locating and observing the true height of Teram Kangri, the high Himalaya peak discovered by Dr. Longstaff during his explorations in 1909.

The two officers, making their head-quarters at Leh, visited several of Montgomerie's old trigonometrical stations, but as no glimpse of Teram Kangri could be obtained from any of these, Mr. Collins proceeded with his plane-table to make a rapid reconnaissance to the north, leaving Mr. Wyatt to follow in his footsteps and bring up the triangulation.

Mr. Collins' last report, dated 6th July, states that he proceeded up the Nubra Valley and obtained observations to Teram Kangri from two peaks and hoped to observe it from a third. Mr. Collins places Teram Kangri 6 miles south-east of the position assigned it by Dr. Longstaff and gives its height as 24,272 ft. The data which Mr. Collins has available for basing his computations are derived from his plane-table and his aneroid barometer and his results cannot therefore be regarded as final; so soon as the triangulation is brought up to his stations of observation, it will be possible to give definite information, both as to the position and height of Teram Kangri. As regards the height, the

error is not likely to be considerable and it may be taken as certain that the final corrected height will not approach that of Mount Everest.

(3) Central India.

The work in Central India consisted of the revision of heights on the Great Arc Series. Work commenced at the Sironj base line on January 20th, 1911, and closed on March 20th, 1911.

In all, the heights of ten stations have been revised. There was a difference of about 5 ft. in the new and old value of the second station Bhaunrasa, the old value being in excess of the new value: this difference remained fairly constant in the remaining eight stations.

Base Lines.

A detachment was engaged in the selection of sites for base lines in Burma, with a view to their measurement, in the near future, by means of the new Invar wire apparatus. This apparatus allows of the measurements of base lines of much greater length than those measured in India by means of the Colby compensation bars and it was hoped that a fairly level stretch from 15 to 20 miles long could be selected.

Mr. McInnes, who was in charge of the work, reconnoitred the country round Myitkyina, Bhamo, Toungoo and Prome, but was unable to obtain suitable sites for base lines of the length proposed. He prepared two sites, one at Bhamo 9 miles in length, the other at Prome about 13 miles long; if more favourable sites cannot be found, the measurement of these lines will have to be undertaken.

The Invar wires themselves were received at Dehra nearly two years ago, but the new metre and four metre standards have not yet been received, so that there has been no possibility of carrying out a comparison of the wires. Until this has been done, no actual measurements can be carried out with the wires.

SECONDARY TRIANGULATION.

Three detachments were employed on secondary triangulation, one in the Southern Shan States, the other two in Assam.

ASTRONOMICAL LATITUDES.

During the season of 1910-11, latitude observations were made at ten stations; of these six were in Sind and Baluchistan, and four in the Siwalik Hills to the south and south-east of Dehra Dun.

Special interest attaches to the Sind observations as they are the first astronomical latitudes which have been taken in this region.

The positions of the stations must be described in some detail.

(1) Khojak h.s. Lat. 30° 51′. Long. 66° 37′. Height 7,851 ft.

The station is on one of the peaks of the Khwaja Amran range, which runs from north-north-east to south-south-west in an almost straight line for many miles. The general topography is fairly similar in character on the two sides of this line; on the west lies Afghanistan, and on the east the knotted hills of Baluchistan. The distribution of the mountains within a radius of 50 miles is such as to lead one to expect no marked deflection of the plumb-line.

(2) Quetta. Lat. 30° 12′. Long. 67° 3′. Height 5,500 ft.

The distance from Khojak h.s. is about 50 miles, Quetta lying to the south-east.

In the surroundings of Quetta there is again an apparent balance of masses to the north and south, and there is no cause for deflection of the plumb-line so evident as to be detected by an inspection of the map.

(3) Mach. Lat. 29° 53′. Long. 67° 21′. Height 3,082 ft.

This station is situated in the Bolan Valley about half way between the point where the railway emerges into the Dasht and that at which it leaves the plains. Here there is a notable excess of hills to the north of the station. To the south-east the hills fade away into the plains, the foot being about 20 miles distant. To the south, though there are hills, they are much less lofty than those to the north. From west to south-west, the hills are high, possibly on the whole rather higher than those that lie between west and north-west, but the excess here is much less marked than the deficiency in the remainder of the southern semicircle. A northerly attraction is therefore to be expected at this station.

(4) Dasti. Lat. 29° 0′. Long. 67° 50′. Height 316 ft.

This station is situated in the plains. Its distance from the foot of the hills is about 25 miles, the nearest point being in a north-west direction. In a northerly direction the hills are about 40 miles distant. If we estimate that from west to north-east (clockwise) a belt between circles of 40 and 80 miles radius respectively is occupied by hills, on the average 5,000 ft. higher than the station, the attraction will be (*vide* Professional Paper No. 5, page 50)—

$$0''{\cdot}000742 \times 5000 \times 1{\cdot}768 = 6''{\cdot}6.$$

This may be taken as a rough indication of the attraction which the topography within 80 miles might be expected to produce. If the investigation be extended it will unquestionably indicate that a larger attraction than the above is to be expected, for the country to the north is all elevated while that to the south is low-lying.

(5) Dumb. Lat. 28° 15′. Long. 68° 17′. Height 183 ft.

This station is situated in the plains a few miles west of Jacobabad. The nearest hills lie about 30 miles to the north-east and 50 miles to the west respectively. An analysis of the topography would undoubtedly show that a northerly attraction was to be expected here.

(6) Sultan-ka-Got. Lat. 28° 4′. Long. 68° 39′. Height 213 ft.

This station is situated near the town of Shikarpur. The characteristics of its situation are similar to those of Dumb, but the hills are now more remote.

The results of the observations are as follows:—

Name of station.	Geodetic Lat.	Astrol. Lat.	A—G.
	° ′ ″	° ′ ″	″
Khojak	30 51 24·60	30 51 20·43*	−4·26
Quetta	30 11 67·37	30 11 56·25	−1·12
Mach	29 52 31·51	29 52 20·16	−11·35
Dasti	30 0 29·03	29 0 27·66	−2·37
Dumb	28 15 21·00	29 15 18·75	−2·25
Sultan-ka-Got	28 4 9·41	28 4 7·97	−1·44

* These values are provisional as the computations are not yet complete.

A negative value of A—G denotes a northerly attraction of the plumb-line. At Khojak and Quetta the results are of the nature that an inspection of the neighbouring topography had led one to expect. There is a passage in Professional Paper No. 5, page 52, on the subject of what inferences could be drawn from an observation taken at a point 'beyond Quetta.'

The present observations though not taken in exactly the region contemplated by Colonel Burrard, yet go some way to prove that the

initial latitude of the survey, namely, that at Kalianpur, is not much affected by local attraction.

The fact that the deflections at Dasti, Dunub and Sultan-ka-Got are so much smaller than that at Much, and the progressive diminution in these deflections, indicate a structure similar to that found at the foot of the Himalayas, namely, a trough of low density at the foot of the hills, succeeded, at a considerable distance, by a belt of abnormally high density.

The present observations point to the conclusion that the place of maximum density is further to the south-east than Sultan-ka-Got. The results of the latitude observations are in good agreement with those of the pendulum observations made in 1906-07. These observations showed a large deficiency in gravity at Sibi and Mach, and an excess at Jacobabad. Further observations both of the intensity and direction of gravity at stations along the Indus and to the south-east of the river are required. The lobe of the mountain region which projects to the south between Sibi and Dera Ghazi Khan is a feature which does not occur elsewhere on the long line of the ranges that shut in the north of India, and it deserves a detailed examination.

Of the four stations in the Siwaliks, Shorpur is on the main ridge, close to the Mohun Pass, where the road from Saharanpur to Dehra crosses it. The other three stations are all on the plains side of the range.

The positions of the stations and the results of the observations are shown in the following table:—

Name of station.	Height.	Long.	Geodetic Lat.	Astrol. Lat.	A—G.
	Ft.	° ′	° ′ ″	° ′ ″	″
Lachkus . .	2,674	78 2	30 4 34·24	30 4 5·20*	−29·04
Hatni . . .	3,096	77 59	30 13 0·44	30 12 31·10	−29·34
Bullawalla . .	2,432	77 59	30 6 51·29	30 6 22·30	−28·99
Shorpur . .	3,016	77 58	30 13 45·59	30 13 14·59	−31·00

* These results are provisional as the computations are not yet complete.

At the east end of the base, which is at the foot of the Siwaliks on the Dun side, nearly due north of Shorpur, the value of A—G is −30″·37, *vide* Professional Paper No. 5, table after page 14.

It is remarkable that the northerly attractions at the east end of the base and at Shorpur are greater than those at the other three stations. It indicates that the approach to the Himalayas is a more important fact than the change from the one side to the other of the Siwaliks. This range is so rugged and precipitous that it is difficult to cross and so appears a formidable barrier, but the amount of matter contained in it is probably not very great and of low density.

Pendulum Observations.

The year's work is interesting as affording the first gravity results yet obtained in Burma. Observations were taken at eleven stations with the results shown in the attached table. The orographical corrections have not been fully computed yet; but in no case can the correction be large, and therefore the results now given may be accepted as representing very closely the actual state of things.

(2) During the recess, computations of the effect of the whole surface of the earth on gravity at stations in India were commenced, using the hypothesis and zones devised by Mr. Hayford of the U. S. Coast and Geodetic Survey in his isostatic enquiries. Commencement was made from the Antipodes, and it has been found possible to use interpolation very freely for the more distant parts of the earth, increasing the number of the computed stations as the zones approach nearer to them.

The stations used for each set of zones are then plotted on a map of India and contours of equal attraction (according to this hypothesis) are thus drawn by interpolation, by means of which the attraction exerted by these particular zones can be read off for any required station in India.

The most laborious part of the work is now done, and by the end of the present recess season it is hoped to bring it to within 300 miles of all stations; after which it will be a very small labour to compute the effect of the complete "Hayford" correction for the whole earth on any desired pendulum station in India or Burma.

The work already done indicates considerable differences of effect, which may somewhat modify the figures used in last year's preliminary discussion, which only included the terrain within 100 miles from the station.

Summary of results, season 1910-11.

No.	Station.	Latitude.	Longitude.	Height above M. S. L.	Observed g.	Correction for height.	Correction for mass.	Correction for terrain.	g_0 = G. corrected for height only.	g'' = corrected for height and mass.	γ_0	$g_0 - \gamma_0$	$g'' - \gamma_0$
		° ′ ″	° ′ ″	Ft.									
1	Rangoon	16 47 55	96 9 0	134	978·467	+0·015	−0·006		978·482	978·476	978·434	+0·048	+0·042
2	Prome	18 49 40	95 13 40	101	978·543	+0·010	−0·004		978·553	978·549	978·541	+0·011	+0·007
3	Henzada	17 39 17	95 27 10	46	978·491	+0·004	−0·002		978·496	978·493	978·479	+0·017	+0·006
4	Bassein	16 47 11	94 44 6	33	978·476	+0·003	−0·001		978·477	978·475	978·433	+0·044	+0·042
5	Toungoo	18 56 50	96 27 3	159	978·553	+0·015	−0·006		978·573	978·567	978·547	+0·026	+0·020
6	Pyinmana	19 44 25	96 11 55	409	978·579	+0·039	−0·014		978·618	978·603	978·583	+0·035	+0·019
7	Meiktila	20 51 35	95 51 55	788	978·617	+0·076	−0·029		978·681	978·663	978·658	+0·023	+0·005
8	Mandalay	21 58 44	96 6 25	344	978·714	+0·051	−0·020		978·737	978·732	978·726	+0·039	−0·000
9	Maymyo	22 1 13	96 30 36	3,485	978·459	+0·336	−0·123		978·816	978·694	978·730	+0·086	−0·036
10	Mogok	22 54 51	96 29 51	3,396	978·439	+0·343	−0·129		978·853	978·723	978·737	+0·116	−0·014
11	Myingyan	21 29 35	95 25 50	340	978·650	+0·053	−0·020		978·713	978·704	978·696	+0·017	+0·008

Tidal Operations.

During the past year tidal registrations by automatic tide gauges have been taken at the ports of Aden, Karachi, Apollo Bandar (Bombay), Prince's Dock (Bombay), Madras, Kidderpore, Rangoon, Moulmein and Port Blair. The registrations at these ports have been satisfactory.

Levelling Operations.

During the year 1910-11 the following lines of precise levelling were run:—

(a) In the Punjab.

1. Ambala to Solon.
2. Dera Ismail Khan to Chunda.
3. Darya Khan to Rawalpindi *vid* Khushab, and Khushab to Shahpur.
4. Rawalpindi to Murree.
5. Nowshera to Risalpur.

(b) In Bombay, Madras and Goa.

1. A number of branch lines to connect bench-marks along the old lines of levels between Bombay and Igatpuri and Bombay and Lonavla with new rock-cut bench-marks in the ghâts.
2. Poona to Ahmadnagar.
3. Morgugna to Bagalkot *vid* Belgaum.
4. Belgaum to Hubli (revision).

(c) In Eastern Bengal and Assam.

1. Gauhati to Dibrugarh.
2. Gauhati to Dumpep *vid* Shillong.

These lines comprise three which run from the plains to the hills, *viz.*, Ambala to Solon, Rawalpindi to Murree, and Gauhati to Shillong.

The programme had originally included an extension from Murree, *vid* Baramula to Srinagar and other points in the valley of Kashmir, but as the Kashmir Durbar took exception to the cost of the connection with the India level net, and as without this the work would have had no geodetic value, the scheme was abandoned.

BOTANICAL SURVEY.

BY

MAJOR A. T. GAGE, I.M.S., M.A., B.Sc., M.B., F.L.S.,
Director, Botanical Survey of India.

Eastern India.—Two fasciculi—comprising 6,000 numbers—of the enumeration and identification of the non-herbaceous phanerogams cultivated in the Royal Botanic Garden, Calcutta, have appeared during the year, while the numbers between 6,000 and 10,000 are now in the press. There are still left over 3,400 numbers for identification before the first part of the catalogue can be nominally completed.

An account of the results of Messrs. Smith and Cave's expedition to the extreme north-west of Sikkim that was referred to in last year's report has been issued as a number of the Records of the Botanical Survey, with a map and two photographic plates. The species new to science yielded by the collection include *Clematis zemuensis, Arenaria thangoensis, Astragalus zemuensis, Potentilla perpusilloides; Saxifraga llonakhensis, S. Caveana, S. coarctata, S. inconspicua; Sedum Levii, S. Smithii, S. Fischeri, S. Carei, S. Oreades, S. Quevai, S. Gagei; Cremanthodium cucullifcrum; Primula atrodentata, P. Caveana, P. flagellaris; Parajaeschkea Smithii, Aphyllorchis Pantlingii, Allium Gageanum.* Of these *Parajaeschkea* is a new genus of *Gentianaceæ* described by Mr. I. H. Burkill. In July-August of 1910, Mr. Smith was deputed to explore the south-east corner of Sikkim, more particularly the ridges lying between the Cho-La and Tanka-La. Both those passes had been visited previously by botanists, but not very much was known of the vegetation of the intervening country. During his tour Mr. Smith collected over 6,000 specimens and made careful observation of the vegetation. A detailed account of the tour and its results will appear in the Records of the Botanical Survey so that here only a brief summary need be given. Summer on the Cho-La range would appear to be short and very rainy, the rain coming more as a steady drizzle than in heavy downpours, with rather a limited amount of sunshine in consequence. The flora is less diverse than that of northern Sikkim. The dominant orders are *Ericaceæ, Primulaceæ, Compositæ, Crassulaceæ, Saxifragaceæ* and in a less degree *Ranunculaceæ, Caryophyllaceæ, Juncaceæ, Cyperaceæ, Gramineæ, Scrophulariaceæ, Gentianaceæ, Salicaceæ.* The more important genera are *Rhododendron, Primula, Senecio, Sedum,*

Saxifraga, Potentilla, Gentiana, Pedicularis, Salix, Swertia, Meconopsis, Ranunculus, Anemone, and in a less degree,—*Juncus, Corydalis, Rheum, Codonopsis, Parnassia, Arisæma.*

Prominent species are:—*Abies Webbiana, Clematis montana, Chrysanthemum Atkinsoni, Swertia Hookeri, Gentiana stylophora, Rhododendron campanulatum, Primula sikkimensis, P. reticulata, P. obtusifolia, P. Stuartii, Trollius pumilus, Meconopsis paniculata, Iris Clarkei, Cardamine macrophylla, Lloydia serotina.*

There were lacking or scanty the tufted Arenarias of north-west Sikkim, *Leguminosæ, Tamarix, Saussurea* and *Coniferæ* except *Abies.*

Mr. Smith notes that "*Ranunculaceæ* are represented chiefly by *Anemone, Caltha, Trollius* and small *Ranunculi.* These occur in large numbers wherever there is any approach to meadow conditions. Aconites are apparently much scarcer than in western Sikkim. Of *Berberideæ, Decaisnea* frequents the moist woods just below 9,000 feet, while *Berberis macrosepala* is a trial to travellers on the higher slopes. *Meconopsis* is plentiful and there are several prolific species of *Corydalis. Cruciferæ* are not well represented, *Cardamine* sps., *Cochlearia* sps. and *Draba elata* being the most conspicuous. The almost entire absence of cultivated land precludes many wide-ranging species usually associated with agriculture. Of *Caryophyllaceæ* the region yielded chiefly species of *Stellaria* and *Arenaria,* mostly straggling forms typical of moist alpine conditions and very different from the 'rosette' plants of those genera in northern Sikkim. *Leguminosæ* are almost entirely absent. *Rosaceæ* are represented chiefly by species of *Potentilla* while *Rosa sericea* and *Geum elatum* are common. *Saxifraga* shows many species though not quite so many as northern Sikkim. This is also true for *Crassulaceæ,* prolific in individuals but restricted in species. *Umbelliferæ* show more species than in northern Sikkim but compare unfavourably with the Singalela range in number of species and individuals. Both *Caprifoliaceæ* and *Rubiaceæ* are poorly represented, the dearth of species of *Lonicera* being noteworthy. Of the abundant *Compositæ* the most conspicuous are species of *Senecio* of which three are new species. *Rhododendron* and *Primula* are the most prevalent genera in the area. *Gentiana* and *Swertia* are also well represented. *Boragineæ* are scarce with the exception of *Paracaryum glochidiatum* and *Onosma Emodi.* In *Solanaceæ, Mandragora caulescens* is the only common plant. As elsewhere in Sikkim, *Pedicularis* is well represented while *Veronica* is not uncommon. In the moist forest *Utricularia* is frequent and two species are found above the forest zone. *Labiatæ* are not common, the most conspicuous members being *Dracocephalum speciosum, Phlomis*

aps. and *Calamintha umbrosa*. Of *Polygonum* there are several species. *Euphorbiaceæ* and *Urticaceæ* are scarce. Prostrate *Salices* are abundant and in the valleys are a few trees of fair height. Among monocotyledones, *Orchis* and *Habenaria* are frequent, round clumps of *Iris Clarkei* in the moist valleys and *Lloydia* everywhere. *Arisæma* is prominent. *Juncaceæ* and *Gramineæ* show an average of species equal to other alpine areas of Sikkim."

More than twenty new or noteworthy species were discovered. In addition to working out the results of his own tours Mr. Smith has also worked up the collection made in Bhutan by Mr. J. C. White, C.I.E., late Political Officer in Sikkim, and the Sikkim collections generally in the Calcutta Herbarium. The following species new to science have so far been yielded by these collections and have been described in No. 6 of Volume IV of the Records of the Botanical Survey:—*Garuga Gamblei*, *Enonymus tibeticus*. *Pirus bhutanica*, *Saxifraga Gageana*, *Pimpinella radiata*, *Pentapterygium sikkimense*, *Primula Whitei*, *P. Jonarduni*, *Buddleia tibetica*, *Aerides Greenii*, *Hedychium Greenii*. The following new species also from the Eastern Himalaya have been described by the Curator of the Herbarium elsewhere:—*Senecio biligulatus*, *S. Lagotis*, *S. Chola*, *Saussurea fibrosa*, *S. Pantlingiana*, *S. nimborum*, *S. Lanceana*, *Gentiana pluriarum*, *Swertia ramosa*, *S. Burkilliana*. Species not hitherto recorded as occurring in the Eastern Himalaya include *Spenceria ramalána* Trim., *Cydonia cathayensis* Hemsl., *Rodgersia pinnata* Franchet, *Ribes Grossularia* L., *Uncaria macrophylla* Wall., *Senecio arnicoides* Wall., *Calorhabdos Brunoniana* Benth., *Trichoderma calycosum* Coll. & Hemsl.

Mr. J. R. Drummond, I.C.S. (retd.), has described the following new species of *Compositæ* from collections made in the Eastern Himalaya by Calcutta Botanic Garden collectors or with their aid by others:—*Senecio lucifer*, *S. rumicifolius*. M. H. Léveillé has published a diagnosis of *Hemibora himalayensis* as a new species of *Gesneraceæ* from the Government Cinchona Plantation, Mungpoo. Mr. W. R. Dykes has described *Iris himalaica* as a new species from near Darjeeling. The moss flora has been studied by Mr. H. N. Dixon who has described as new species from the Eastern Himalaya *Mercyopsis minuta*, *M. sikkimensis*, *M. angulosa* and *Hymenostylium anotinum*.

A notable contribution to our knowledge of the vegetation of Bengal is "A Forest Flora of Chota Nagpur including Gangpur and the Santhal Parganahs" by Mr. H. H. Haines, Deputy Conservator of Forests. Although nominally a Forest Flora the work includes reference also to the

principal economic herbs and the more commonly cultivated trees and shrubs. The area dealt with is over 37,400 square miles in extent and, with the exception of a strip of the Gangetic plain lying along the east and north of the Santhal Parganahs, is composed of plateaux and hills that vary from 400 to 3,000 feet in elevation. A succinct account is given of the topographical and geological features and a comprehensive account of the climate and rainfall of the area. The vegetation is essentially of the monsoon forest type and more or less deciduous during the dry months, although the cool valleys and the tops of some of the highest hills exhibit a vegetation differing somewhat from the general type. The most characteristic tree of the area is *Shorea robusta* Gærtn. (the Sal), which on the driest aspect gives place to such species as *Cleistanthus collinus* Benth., *Anogeissus latifolia* Wall., *Odina Wodier* Roxb., *Nyctanthes Arbor-tristis* Linn. and others of the "mixed forest" type. On the driest rocks purely xerophilous species occur, such as the fleshy *Euphorbias* and *Sarcostemma*. Most of the species avoid the evils of excessive transpiration during the dry season by declining to wear any leaves. Mr. Haines mentions *Sterculia urens* Roxb., *Odina Wodier* Roxb. and *Cochlospermum Gossypium* DC. as typical examples of trees leafless from November to May or June.

The area is characterised by the general association of *Shorea robusta* Gærtn., species of *Anogeissus*, *Bassia latifolia* Roxb., species of *Gardenia*, *Butea* and *Schleichera* and the grasses *Ischæmum angustifolium* Hack. and *Heteropogon contortus* Roem. The common sub-Himalayan associates of the Sal, such as *Dillenia pentagyna* Roxb., *D. indica* L., *Careya arborea* Roxb., *Stereospermum chelonoides* DC. and *Sterculia villosa* Roxb. are scarce in the area, while Teak, *Dalbergia sissoo* Roxb., *Cupuliferæ* and *Coniferæ* are entirely absent in a wild state. *Rubiaceæ* especially of the genera *Gardenia* and *Wendlandia*, *Acanthaceæ*, species of *Bauhinia*, *Diospyros*, *Terminalia*, *Zizyphus* and such species as *Cleistanthus collinus* Benth., *Nyctanthes Arbor-tristis* L., *Ægle Marmelos* Corr. and *Dendrocalamus strictus* Nees abound.

Dillenia pentagyna Roxb., the common sub-Himalayan associate of the Sal, is replaced in Chota Nagpur by *Dillenia aurea* Sm. The *Anonaceæ* are fairly well represented, as also are the small families *Menispermaceæ*, *Capparidaceæ*, *Polygalaceæ*, *Combretaceæ* and *Lythraceæ*. On the other hand *Urticaceæ*, *Magnoliaceæ*, *Ranunculaceæ*, *Cruciferæ*, *Guttiferæ*, *Ternstræmiaceæ*, *Rosaceæ*, *Umbelliferæ* and *Lauraceæ* are poorly represented. The more important orders according to the number of species represented are *Gramineæ*, *Leguminosæ*, *Cyperaceæ*, *Orchidaceæ*,

Compositæ, Euphorbiaceæ, Acanthaceæ, Rubiaceæ, Scrophulariaceæ, Filicales, Labiatæ, Urticaceæ, Cucurbitaceæ. Altogether about a thousand species are described or referred to. Keys to the genera and species are furnished and notes added with reference to such practical points as habitat, times of flowering and fruiting, renewal of the leaves and such like. A good map accompanies the volume.

In Assam Mr. I. H. Burkill, while officiating as Director of the Botanical Survey, made along with Mr. S. C. Banerji a tour in the Khasia Hills district. His collections are now being worked up.

The collections previously made in Assam were worked up as far as possible partly by the Herbarium staff at Calcutta and partly by botanists in Europe. From Mr. Meebold's Manipur collections—referred to in the report for 1908-09—the following new species have been described:—*Impatiens spinisflora, I. tenuriflora, I. longirama, I. gibbisepala, I. odontosepala, I. rubrolineata*, and a new variety of *I. tripetala* Roxb. and of *I. lævigata* Wall., by the late Sir Joseph Hooker, and *Epipremnum Meebaldii* by K. Krause. From other collections there have been described as new species—*Justicia Craibii* by the Curator of the Calcutta Herbarium, *Uraria Lacei* by W. G. Craib of the Kew staff, *Prunus (Padus) bracteopadus* by E. Koehne, *Cirsium Lipskyi* by Fr. Petrak, *Potamogeton orientalis* by G. Hagström, *Tinospora Mastersi* by L. Diels.

Mr. I. H. Burkill has observed the further spread in Assam of the American species *Croton sparsiflorus* Morung that was referred to in last year's report as a recent introduction to India. Mr. Burkill found it at Shamshernagar, at Tilagaon, at "mile 206" a halting place for Hafiong, at Lumding and at Gauhati. The species seems to have spread from Chittagong as its point of arrival in India.

In Burma Mr. A. Meebold has partly explored the district of Tavoy, but his collections therefrom still remain to be worked up. In northern Burma Captain S. M. Toppin, R.G.A., collected over the hitherto unexplored country between Mogoung and the Chindwin river, his route being through Kamain, Haungpa and Nainpaw. These collections also still remain to be worked up. Mr. Toppin has in addition contributed to the Survey his collections made in the neighbourhood of Bhamo. Captain R. W. MacGregor, I.M.S., has sent from the Shan States an interesting collection of about 1,600 specimens. Messrs. A. Rodgers, G. E. S. Cubitt, and H. W. A. Watson, Deputy Conservators of Forests, have sent material from respectively the Ruby Mines district, the Bhamo

division and Taunggyi. These and previous collections made by the same officers, by Mr. J. H. Lace, Chief Conservator of Forests, and by Mr. Meebold, have been to a considerable extent worked up by the Calcutta Herbarium staff and by botanists in Europe. So far these collections have yielded the following species new to science:—*Manglietia Hookeri*, *Melodorum minuticalyx*, *Paranephelium Hystrix*, *Craibiodendron shanicum* (a new genus), *Beaumontia brevituba*, *Didymocarpus bracteatus*, *D. graciliflorus*, *Stereospermum grandiflorum*, *Nyctocalos shanica*, *Ione salweenensis*, *Stauropsis shanica* described by the Curator of the Calcutta Herbarium; *Pueraria alopecuroides*, *Indigofera Laeei*, *Ophiorrhiza Laeei*, *Adenosacme chasalioides*, *Gymnema Laeei*, *Swertia Laeei* by Mr. W. G. Craib of the Kew Herbarium; *Impatiens Laeei* by the late Sir Joseph Hooker; *Oxytenanthera Laeei* by Mr. J. S. Gamble; *Osbeckia Hildebrandii* by Dr. O. Stapf; *Carex plesiocephala* by Mr. Turrill; *Xylia Kerrii* by Messrs. Craib and Hutchinson; *Amorphophallus kachinensis* by Dr. Engler and Herr Gehrman, *A. Krausei* by Dr. Engler. From the collections made many years ago in the Malayan region by Calcutta Botanic Garden collectors and others Mr. J. S. Gamble has described the following new species of *Lauraceæ*:—*Cinnamomum graciliflorum*, *C. Ridleyi*, *C. Dechampsii*, *C. Scortechinii*, *C. aureo-fulvum*, *C. cinereum*; *Alseodaphne Wrayi*, *A. paludosa*, *A. insignis*, *A. Ridleyi*, *A. pendulifolia*, *A. borneensis*; *Notaphœbe fruticosa*, *N. Kingiana*, *N. reticulata*, *N. sarawacensis*, *N. Havilandi*; *Machilus Scortechinii*; *Phœbe Kunstleri*, *P. Forbesii*; *Stemmatodaphne perakensis*; *Actinodaphne montana*, *A. Ridleyi*, *A. johorensis*, *A. oleifolia*, *A. Hullettii*, *A. cuspidata*, *A. fragilis*; *Litsea johorensis*, *L. trunciflora*, *L. artocarpifolia*, *L. gracilis*, *L. Ridleyi*, *L. quercina*, *L. cylindrocarpa*, *L. Wrayi*, *L. Teysmanni*, *L. machilifolia*, *L. hirsutissima*, *L. jenestrata*, *L. Foxiana*, *L. monticola*, *L. Scortechinii*, *L. oblanceolata*, *L. Kunstleri*, *L. claviflora*, *L. Curtisii*, *L. megacarpa*, *L. nidularis*, *L. sarawacensis*, *L. ujongensis*; *Nevlitsea mollissima*, *N. kedahensis*, *Lindera Wrayi*. Sir Joseph Hooker had described two new species of Balsam from the same region—*Impatiens peltata* and *I. Vaughanii*—and Lieutenant-Colonel Prain has figured and re-described a new Labiate genus and species *Acrymia ajugiflora*. Other new species from the same region are *Amorphophallus perakensis* and *A. carnosus* described by Dr. Engler and *Tinospora macrocarpa* and *T. andamanica* by Dr. Diels, and *Selaginella strigosa* by the late Colonel Beddome.

Southern India.—From Madras, Dr. C. A. Barber, Madras Government Botanist, has contributed to the Survey over 800 specimens

Mr. C. E. C. Fischer, Deputy Conservator of Forests, has as usual sent a rich collection of over 1,600 specimens. Mr. Alfred Meebold during the later months of 1910 made an extensive tour through the States of Cochin and Travancore, which yielded a fine collection including rare and new species. Mr. Meebold has presented a set of over 2,000 sheets to the Calcutta Herbarium. The new species published during the year from these and from previous collections from Southern India include *Vernonia Meeboldii, V. comorinensis, Anaphalis travancorica, A. Meeboldii* described by the Curator of the Calcutta Herbarium; *Oldenlandia Prainiana, Strobilanthes Meeboldii* by Mr. W. G. Craib; *Impatiens Nataliæ, I. bababudenensis, I. microtheca, I. lenta, I. trichocarpa* by Sir Joseph Hooker; *Anaphyllum Beddomei* by Dr. Engler.

Mr. Meebold has published a sketch of the vegetation of Mysore and Mr. R. J. D. Graham, Economic Botanist, Nagpur, has published a useful list of the wild plants—except grasses and sedges—found on the Nagpur and Telinkheri farms. He enumerates 309 species belonging to 205 genera and 56 orders and gives a short description of each species, its frequency of occurrence, time of flowering, vernacular name and use.

Western India.—Mr. G. A. Gammie has continued his studies of the orchids of the Bombay Presidency and has published an account of the species of the genera *Pogonia, Spiranthes, Zeuxine*, and *Cheirostylis*. Mr. W. Burns, Economic Botanist, has described a *Tamarix* association and the sea-shore vegetation in the neighbourhood of Bassein. He has also presented the Survey with a small but interesting collection of specimens from the Bombay side. During the year he and his assistants collected in various districts of the Presidency. A new species of Balsam—*Impatiens rupicola*—was described by Sir Joseph Hooker.

A second list of mosses from Western India has been published by Mr. L. J. Sedgwick, I.C.S., in which twenty genera are enumerated. Mr. Sedgwick points out that Western India is practically an untouched field as far as the study of mosses is concerned. From amongst the moss collections made by Mr. Sedgwick and others, Mr. H. N. Dixon has described a new genus *Hyophilopsis* and the following new species—*Hyophilopsis entosthodontacea, Bryum sahyadrense, B. ghatense, Mereeyopsis pellucida, Campylopus Sedgwickii, Fissidens Sedgwickii, Calymperes tortelloides*. Professor W. West has described a new Alga *Polypothrix lophodellophila* which was discovered by Dr. N. Annandale in association with freshwater Polyzoa in Igatpuri Lake.

Northern India.—During the year, collections were made in Kumaon by Indian collectors working under the supervision of Mr. N. Gill of the Government Gardens in Kumaon. Captain S. M. Toppin, R.G.A., contributed a small collection of Malakand plants gathered by himself when stationed in that part of India.

The second volume of Mr. J. F. Duthie's "Flora of the Upper Gangetic Plain" has been issued during the year. The scope of this Flora was referred to in the report for 1908-09. The present volume contains descriptions of the species in the orders from *Plumbaginaceæ* to *Plantaginaceæ*, comprising 26 orders, 185 genera and 331 species. The more important orders as regards specific richness are *Acanthaceæ* with fifty-one species, *Labiatæ* with forty, *Scrophulariaceæ* with thirty-seven, *Convolvulaceæ* with thirty-four, *Asclepiadaceæ* with thirty-three, *Boraginaceæ* with twenty-four. Colonel J. C. Bamber, I.M.S., has continued his descriptive Key to the Flora of the Punjab, North-West Frontier Province and Kashmir. Sir Joseph Hooker published an account of the *Balsaminaceæ* of the State of Chitral, in which he enumerates eight species of *Impatiens*.

Mr. R. N. Parker, Deputy Conservator of Forests, has studied the forest vegetation of Hazara district and has made out a provisional list of species occurring there. His observations have increased the geographical range of not a few species, but details cannot well be given here.

From the previous collections of various botanists the following new species have been described during the year:—*Gerbera Lawii* by Sir George Watt, *Aristolochia punjabensis* by Mr. J. H. Lace, *A. dilatata* by Mr. N. E. Brown; *Impatiens Meeboldii*, *I. pahalgamensis*, *I. Reidii*, *I. Jaschkei*, *I. Aitchisonii*, *I. Stoliczkai*, *I. vexillaria*, *I. polysciadia*, *I. Langeana*, *I. coriusepala* by Sir Joseph Hooker; *Prunus anadenia* and *P. glaucifolia* by Herr E. Koehne.

In the moss flora of the North-West Himalaya Mr. H. N. Dixon has described as new species—*Mercyopsis minuta* (also in the Eastern Himalaya), *M. hymenostylioides*, *Hymenostylium Shepherdæ*, and from Lucknow *Hyophila subfaceula*—also occurring near Bombay.

Additions to the known Flora.—The number of new phanerogamic species added since last year's report to the flora of India within the area covered by Sir Joseph Hooker's "Flora of British India" is not less than one hundred and eighty.

General Systematic.—The Rev. Father Blatter, S.J., has published three more instalments of his account of the palms of British India and

Ceylon. The species described so far belong to the genera *Phœnix*, *Chamærops*, *Trachycarpus*, *Rhapis*, *Coccothrinax*, *Thrinax*, and *Corypha*. Full descriptions are given of the species, and notes on their geographical range, flowering time, uses, English and vernacular names. There are copious references to the literature of the subject and the papers are illustrated with figures of flower analyses and with photographic plates of living specimens, a fair proportion of the photographs having been supplied by the Calcutta Botanic Garden. Signor Beccari's Monograph on "The species of the genus Dæmonorops" appeared during the year as Part I of Vol. XII of the Annals of the Royal Botanic Garden, Calcutta. The genus *Dæmonorops* belongs to the *Lepidocaryeæ* division of palms to which *Calamus*—the subject of a previous monograph by the same author—belongs. The geographical area of the genus is comprised between Lat. 10° S. and 25° N. and between Long. 85° and 132° E., with the greatest frequency of species in the Malayan Archipelago. Signor Beccari in an introductory essay gives a general account of the morphology of the various organs, the uses of the genus, and a more detailed account of the geographical distribution of the species. A key to the species is followed by very full descriptions of the individual species and varieties with critical observations. Altogether 91 species are described of which the following are new to science:—*Dæmonorops acamptostachys*, *D. arucusis*, *D. asteracanthus*, *D. bakauensis*, *D. Binnendykii*, *D. Clemensianus*, *D. floridus*, *D. Hallierianus*, *D. Lokerianus*, *D. pachyrostris*, *D. spectabilis*, *D. Treubianus*, *D. turbinatus*. The monograph is illustrated with two plates of analytical figures and 109 magnificent double plates of the species described, and—like its predecessor the monograph on *Calamus*—is one of the finest contributions to botanical science that have appeared in recent years.

Mr. I. H. Burkill has published in the Records of the Botanical Survey an account of the Prickly Pears now wild in India. He gives a general sketch of the distribution throughout the world of the species of the genus *Opuntia* to which the Prickly Pears belong, a detailed account of the occurrence of the five species found in India, a history of their introduction and spread, and their connection with the cochineal insect. A key to the species now wild in India and references to illustrations and descriptions in standard works are furnished as well as critical notes. A map showing the distribution of the genus in India is appended.

Mr. A. W. Lushington, Conservator of Forests, has written a critical paper on the genus *Citrus*, in which after discussing the inconsistencies

in the various accounts of this perplexing genus he gives a synoptical table distinguishing eighteen forms with varieties and sub-varieties. Mr. J. R. Drummond has summarised the more recent information regarding *Agave lurida* and allied species. Mr. S. T. Dunn has rearranged several Indian and Malayan species hitherto included in the genus *Millettia* under the genus *Padbruggea* and a new genus to which Mr. Dunn gives the name *Adinobotrys*. The same botanist has also published a revision of the genus *Actinidia*, giving an account of its history, systematic position—which Mr. Dunn would seem to refer to the *Ternstroemiaceæ*—geographical distribution, and an enumeration of and key to the species. A map showing the sectional distribution of the genus accompanies the paper. M. A. Finet has described as distinct species *Bulbophyllum cylindraceum* Ldl. and *B. khasianum* Griff. that are treated as one species in the Flora of British India. Professor M. Miyoshi has discussed the variability of *Prunus Puddum* Roxb. as exhibited in the Eastern Himalaya and the characters that distinguish the species from *P. campanulata* Maxim. of Japan.

Mr. W. B. Hemsley has cleared up the confusion between *Diospyros Kaki* Linn. f. and *D. Roxburghii* Carrière. Hitherto the latter has been included in the former, but Mr. Hemsley demonstrates that the true *D. Kaki* is confined to Central and Eastern China and Japan, whereas *D. Roxburghii* is a native of Eastern India and Western China.

Iris Clarkei Baker, *Aster Falconeri* Hutchinson and *Meconopsis simplicifolia* Walp. have been figured in the Botanical Magazine.

Several orders and genera represented more or less in India have been studied from the systematic side by various botanists in Europe and America. As such work has a bearing upon the botany of India, brief reference is here called to it. The list of papers at the end of this sketch of the year's work indicates where the reader may look for further information. It is sufficient here to mention the following orders and genera:—*Compositæ*, *Menispermaceæ*, *Loganiaceæ*, *Papaveraceæ*, *Nyctaginaceæ*, *Olacineæ*, *Malvaceæ*, *Sterculiaceæ*, *Tiliaceæ*, *Rutaceæ*, *Myristicaceæ*, *Simarubaceæ*, *Connaraceæ*, *Barleria*, *Pedicularis*, *Juncus*, *Peperomia*, *Doronicum*, *Strychnos*, *Palaquium*, *Sideroxylon*, *Eremurus*, *Leea*, *Grewia*, *Tetrastigma*, *Cissus*, *Cayratia*; *Opuntia*, *Atalantia*, *Masterma*, *Ougeinia*, *Cornus*, *Epilobium*, *Pogostemon*, *Aglaia*, *Amoora*, *Lansium*, *Saponaria*, *Scrophularia*, *Coffea*.

Anatomical, morphological and physiological.—In India Mr. I. H. Burkill has continued his studies in pollination and has published his observations on the plants of the Central Provinces and Berar.

The plants chiefly observed were Cotton, *Elæodendron glaucum* Pers., *Hardwickia binata* Roxb. and *Dalbergia Sissoo* Roxb. Five species of insects were seen to visit cotton flowers and Mr. Burkill's results support the views of Messrs. Middleton, Leake and Fyson that cross-fertilisation occurs naturally in cotton in opposition to Mr. G. A. Gammie's statement that cotton plants are not naturally cross-fertilised. Mr. C. E. C. Fischer has a paper on the effects of the poisonous juice of *Semecarpus Anacardium* Linn. f. A remarkable example of leaf variation in an individual of *Sterculia alata* Roxb. cultivated in the Calcutta Botanic Garden has formed the subject of independent papers by Mr. W. W. Smith and by Professor M. Miyoshi. Mr. V. N. Hate has published a note on the structure of the giant creeper *Calycopteris floribunda* Lamk. which is remarkable for its capacity for storing water. Professor Miyoshi has written an account of the physiognomy of the vegetation of the outer hills of the Himalayan range.

Outside India a number of orders, genera and species that as occurring in or represented in India are of Indian interest have been investigated by botanists in Europe or America. In a fair proportion of cases the Royal Botanic Garden, Calcutta, aided the investigation by supplying in part or in whole the material. These researches are indicated in the list of papers appended. They include work on *Tamaricaceæ*, *Pandanus*, *Orchidaceæ*, *Lythraceæ*, *Anacardiaceæ*, *Dipterocarpeæ*, *Urticaceæ*, *Musa*, *Piperaceæ*, *Dendrobium*, *Oryza sativa* L., *Eriobotrya japonica* Ldl., *Ardisia crispa* A.DC., *Agave*, *Trapa natans* L., *Ficus*, *Dracæna*, *Cordyline*, *Carica Papaya* L., *Morus*, *Nymphæaceæ*, *Diospyros Kaki* L., *Podocarpineæ*, *Podostemonaceæ*.

A list of papers containing references to the Botany of India published mostly during 1910-11.

BAMBER, C. J. . . Plants of the Punjab. Part VI. (*Journ. Bomb. Nat. Hist. Soc., xx, 1910-11, Nos. 2-4, p. 468-502, 800-836, 1084-1102.*)

BEAUVERD, G. . . Contributions à l'étude des Composées asiatiques. II-IV. (*Bull. Soc. Bot. Genève, 1910, p. 36-51, 99-145, 207-253.*)

BECCARI, O. . . The species of the genus Dimorphorpe. (*Ann. Roy. Bot. Gard., Calcutta, xii, Part i, 1911, pp. 239, with 109 plates and 2 plates of analytical figures.*)

BEDDOME, R. H. . . *Selaginella strigosa* in "Decades Kewenses." (*Kew Bull., 1911, No. 1, p. 192.*)

BENOIST, R. . . Espèce et localités nouvelles de *Barleria*. (*Notulæ Systematicæ, i, No. 12, p. 362.*)

BLATTER, E. J. . The Palms of British India and Ceylon. II-IV. (*Journ. Bomb. Nat. Hist. Soc., xx, 1910-11, Nos. 2-4, p. 347-360, 675-706, 981-995, with 16 plates and 1 map.*)

BONATI, G. . . Contribution à l'étude du genre *Pedicularis*. (*Bull. Soc. Bot. France, lvii, 1910, Mem. 18.*)

BROWN, N. E. . *Aristolochia dilatata* in "Decades Kewenses." (*Kew Bull., 1911, No. 6, p. 274.*)

BRUNNER, C. . . Beiträge zu vergleichenden Anatomie der Tamaricaceen. (*Dissert. Erlangen, 1909, pp. 94.*)

BURKILL, I. H. . Notes on the pollination of flowers in India. Note No. 7. A few observations made in the Central Provinces and Berar. (*Journ. Asiat. Soc. Beng., ni, 1910, No. 3, p. 101-107.*)

" . . Notes from a journey to Nepal. (*Rec. Bot. Surv. Ind., iv, No. 4, 1910, p. 59-140, with map.*)

" . . Note on the spreading of *Croton sparsiflorus* Morung along the Assam-Bengal Railway. (*Journ. & Proc. Asiat. Soc. Beng., vi, 1910, No. 8, p. ci-cii.*)

" . . Determinations of the Prickly Pears now wild in India. (*Rec. Bot. Surv. Ind., iv, 1911, No. 6, p. 287-322, with a map.*)

BURNS, W. . . A *Tamarix* association. (*Journ. Bomb. Nat. Hist. Soc., xx, 1910, p. 198-200.*)

" . . A study of sea-shore vegetation. (*Journ. Bomb. Nat. Hist. Soc., xx, 1911, p. 1024-1027.*)

CAMPBELL, D. H. . The Embryo-sac of *Pandanus*. (*Bull. Torr. Bot. Club, xxxvi, 1909, p. 205-220, with 2 plates.*)

CAMUS, A. . . Contribution à l'étude des espèces asiatiques du genre *Juncus*. (*Notulæ Systematicæ, i, 1910, No. 9, p. 274-283.*)

CANDOLLE, C. DE . Note sur la distribution geographique des espèce du genre *Peperomia*. (*Bull. Geogr. Bot., xx. 1911, p. 3-6.*)

CAVILLIER, F. . Nouvelles études sur le genre *Doronicum*. (*Ann. Conservat. et Jard. Bot. Genève, 1909-10, p. 195-368, with 1 plate.*)

CRAIB, W. G. . [Diagnoses of new species in] "Decades Kewenses." (*Kew Bull., 1910, p. 275-280, 382, and 1911, p. 189-191.*)

CRAIB, W. G., & HUTCHINSON, J. — *Xylia Kerrii* (*Hooker's Ic. Plant.*, x, 1911, *Pt.* 2, *tab.* 2932.)

CZAPEK, F. — Beitrage zur Morphologie und Physiologie der epiphytischen Orchideen Indiens. (*Sitzungsber. Kais. Akad. Wiss. Wien, 1909, cxviii, p. 1555-1580.*)

„ — Ueber die Blattentfaltung der Amherstieen. (*Sitzungsb. Math.-Nat. Kl. Kais. Akad. Wiss. Wien, cxviii, 1, 1909, p. 201-230, with 4 plates.*)

DIELS, L. — *Menispermaceæ*. (*Das Pflanzenreich, 1910, Heft 46, pp. 345.*)

DIXON, H. N. — *Mercyopsis*, a new genus of Mosses, with further contributions to the Bryology of India. (*Journ. Bot., xlviii, 1910, No. 576, p. 297-310, with 2 plates.*)

„ — *Hygophilopsis*, a new genus of *Pottiaceæ*, with further contributions to the Bryology of India. (*Journ. Bot., xlix, 1911, No. 581, p. 137-150, with 1 plate.*)

DOP, P. — Sur les *Strychnos* de l'Asie Orientale. (*Compt. Rend. Acad. Sc., 1910, p. 1256-1275.*)

„ — Contribution à l'étude des Loganiacées asiatiques de l'herbier du Muséum de Paris. (*Bull. Soc. Bot. France, lvii, 1910, Mem. 19, pp. 30.*)

DRUMMOND, J. R. — *Agave lurida*. (*Kew Bull., 1910, p. 344-349.*)

„ — Descriptions of several new species of *Compositæ* in "Dendus Kewensis." (*Kew Bull., 1911, No. 6, p. 270-272.*)

DUBARD, M. — Recherches sur le genre *Palaquium*. (*Bull. Soc. Bot. France, lvi, 1909, Mem. 16, pp. 24.*)

„ — Remarques sur la classification des Sideroxylées. (*Compt. Rend. Acad. Sc. Paris, clii, 1911, 7, p. 390-393.*)

DUNN, S. T. — *Adinobotrys* and *Padbruggea*. (*Kew Bull., 1911, p. 193-198.*)

„ — A Revision of the Genus *Actinidia* Lindl. (*Journ. Linn. Soc., xxxix, No. 278, p. 394-410, with a map.*)

DYKES, W. R. — *Iris himalaica*. (*Gard. Chron., xlv, 1909, p. 3.*)

EBERHARDT, PH. — Considérations sur l'origine du Sésame. Son introduction et répartition en Indo-Chine. (*Bull. Mus. Hist. Nat. Paris, 1909, pp. 30.*)

ENGLER, A. . . . *Araceæ-Lasioideæ.* (*Das Pflanzenreich, iv, 23C, pp. 190, with 44 figures.*)

FEDDE, F. . . . *Papaveraceæ-Hypecoideæ* et *Papaveraceæ-Papaveroideæ.* (*Das Pflanzenreich, 1910, Heft 40, pp. 430.*)

FEDTSCHENKO, O. . . *Eremurus.* Kritische Uebersicht der Gattung. (*Mem. Acad. Imp. Sc. St. Petersbourg, xviii, 1909, pp. 210, with 24 plates.*)

FIEDLER, H. . . . Beiträge zur Kenntnis der Nyctaginiaceen. (*Bot. Jahrbuch., xliv, 1910, No. 5, p. 572-605.*)

FINET, A. . . . *Bulbophyllum cylindraceum* Ldl. et *B. khasyanum* Griff. (*Notulæ Systematicæ, i, 1910, No. 7, p. 193-194.*)

FISCHER, C. E. C. . . Poisonous plants. *Semecarpus Anacardium* Linn. f. var. *cuneifolia.* (*Ind. Forest., xxxvi, 1910, p. 361-362.*)

GAGE, A. T. . . . Catalogue of non-herbaceous Phanerogams cultivated in the Royal Botanic Garden, Calcutta. Part I. Numerical list. 1st and 2nd Fasciculi. (*Rec. Bot. Surv. Ind., v, Nos. 1 and 2, p. 1-168, with map.*)

GAGNEPAIN, F. . . . Sur la famille des Olacacées. (*Bull. Soc. Bot. France, lvii, 1910, No. 5, p. 373-380.*)

" . . . Essai d'une classification des *Leea* asiatiques. (*Bull. Soc. Bot. France, lvii, 1910, No. 6, p. 331-336.*)

" . . . Malvacées et Sterculiacées nouvelles de l'Indo-Chine. (*Notulæ Systematicæ, i, 1909, No. 8, p. 77-85.*)

" . . . Essai d'une classification du genre *Grewia.* (*Notulæ Systematicæ, i, 1909, Nos. 4-5, p. 119-132.*)

" . . . Tiliacées nouvelles d'Asie. (*Notulæ Systematicæ, i, 1910, No. 5, p. 132-137.*)

" . . . Essai de classification du genre *Tetrastigma.* (*Notulæ Systematicæ, i, 1910, Nos. 10-11, p. 306-326.*)

" . . . Un genre méconnu: classification des *Cissus* et *Cayratia.* (*Notulæ Systematicæ, i, 1910, Nos. 11-12, p. 339-362.*)

GAMBLE, J. S. . . . *Oxytenanthera Lacei*, in "Decades Kewenses." (*Kew Bull., 1910, p. 385, and 1911, p. 192.*)

GAMBLE, J. S. . . New *Lauraceæ* from the Malayan region. II-IV. (*Kew Bull., 1910, p. 218-228, 312-321, 357-368.*)

GAMMIE, G. . . Orchids of the Bombay Presidency. XI. (*Journ. Bomb. Nat. Hist. Soc., xx, 1911, No. 3, p. 597-602.*)

GIN, A. . . Recherches sur les Lythracées. (*Lons-le-Saunier, 1909, p. 166, with 3 plates.*)

GORIS, M. A. . . Contribution à l'étude des Anacardiacées de la tribu des Mangiférées. (*Ann. Sc. Nat., Bot., xi, 1910, p. 1-29.*)

GRAHAM, R. J. D. . . List of Wild Plants found on the Nagpur and Telinkheri Farms. (*Nagpur, 1911, pp. 96.*)

GRIFFITHS, D. . . Illustrated studies in the genus *Opuntia*. (*Rept. Missouri Bot. Gard., xxi, p. 165-174, with 10 plates.*)

GUERIN, P. . . . Recherches sur la structure anatomique de la fleur du fruit, et en particulier de la graine des Diptérocarpées. (*Bull. Soc. Bot. France, lviii, 1911, Nos. 1-3, p. 9-17, 39-48, 82-89.*)

" . . . Cellules à mucilage chez les Urticées. (*Bull. Soc. Bot. France, lviii, 1910, No. 5, p. 399-406.*)

GUILLAUMIN, A. . . Revision des *Atalantia* asiatiques. (*Notulæ Systematicæ, i, 1910, No. 6, p. 175-184.*)

" . . Espèces ou localités nouvelles pour les Rutacées d'Extreme-Orient. (*Notulæ Systematicæ, i, 1910, No. 7, p. 207-224.*)

HAGSTRÖM, O. . . *Polumogetones* novi. (*Repert. spec. nov., viii, 1910, p. 145-148.*)

HAINES, H. H. . . A Forest Flora of Chota Nagpur including Gangpur and the Santal-Parganahs. (*Calcutta, 1910, pp. VII + 634 + xxxii.*)

HAMET, R. . . Note sur deux espèces nouvelles de *Sedum*. (*Repert. spec. nov., viii, 1910, p. 263-266.*)

HARMS, H. . . Über die Verbreitung der Leguminosen-Gattung *Mastersia*. (*Repert. spec. nov., ix, 1911, p. 367-369.*)

HATE, V. N. . . Two species of *Chara* from the Bombay Island. (*Journ. Bomb. Nat. Hist. Soc., xix, 1909, No. 3, p. 762-763.*)

HATE, V. N. . . . A note on the structure of the giant creeper *Calycopteris floribunda*. (*Journ. Bomb. Nat. Hist. Soc., xx, 1911, No. 3, p. 837-840, with 1 plate.*)

HAYEK, A. v. . . Entwurf eines Cruciferen-Systems auf phylogenetischer Grundlage. (*Bot. Centralb. Beih., xxvii, 1911, 1st Abt., Heft 2, p. 137-335, with 5 plates.*)

HEMSLEY, W. B. . . Persimmons. [*Diospyros Kaki* Linn. f. and *D. Roxburghii* Carrière.] (*Kew Bull., 1911, No. 5, p. 234-246.*)

HIMMELBAUER, W. . . Eine blütenmorphologische und embryologische Studie über *Datisca cannabina* L. (*Sitzungsb. kais. Akad. Wiss. Wien, mathem.-nat. kl., cxviii, 1, 1909, p. 91-113, with 1 double plate.*)

HOCHREUTINER, B. P. G. . Sur un point de nomenclature relatif du genre *Ongrinia*. (*Ann. Conservat. et Jard. Bot., Genève, 1909-10, p. 50-51.*)

HOOKER, J. D. . . Indian species of *Impatiens*. (*Kew Bull., 1910, p. 291-300.*)

" . . *Hooker's Icones Plantarum, x, Pt. 1, 1910, Tab. 2901-2925.* [Contains descriptions of Indian and Indo-Chinese species of Impatiens, mostly new.]

" . . On the *Balsaminaceæ* of the State of Chitral. (*Kew Bull., 1911, No. 5, p. 209-211.*)

" . . On some species of *Impatiens* from the Malayan Peninsula: II. (*Kew Bull., 1911, No. 6, p. 249-250, with 1 plate.*)

JAHKEL, P. . . Ueber Anatomie und Microchemie der Bananenfrucht und ihrer Reifungserscheinungen. (*Diss. 1909, pp. 41.*)

JOHNSON, D. S. . . Studies in the development of the *Piperaceæ*. (*Journ. exp. Zoöl., ix, 1910, p. 715-749.*)

KERR, A. F. G. . . Notes on the pollination of certain species of *Dendrobium*. (*Notes Bot. School Trin. Coll., Dublin, ii, 1909, p. 31-37, with 1 plate.*)

KOEHNE, E. . . . Was ist *Cornus macrophylla?* (*Mitt. deutsch. dendrol. Ges., xviii, 1909, p. 122-125.*)

" . . . *Prunus*, sub-genoris *Padi*, species novæ. (*Repert spec. nov., ix, 1910, p. 33-37.*)

" . . . Die Gliederung von *Prunus*, Sub-genus *Padus*. (*Verh. bot. Ver. Prov. Brandenburg, vii.*)

KRAUSE, K. . . . Neue Araceen. (*Bot. Jahrbüch., xliv, 1910, Beib No. 101, p. 9-14.*)

KUWADA . . A cytological study of *Oriza sativa* L. (*Bot. Mag. Tokyo, xxiv, 1910, p. 267-281, with 1 plate.*)

LACH, G. H. . . *Aristolochia punjabensis* in "Decades Kewenses." (*Kew Bull., 1911, No. 6, p. 273-274.*)

LECOMTE, H. . . Les Myristicacées d'Indo-Chine. (*Notulæ Systematicæ, i, 1909, No. 4, p. 981-01.*)

" . . Simaroubacées de l'Indo-Chine et de la Chine. (*Notulæ Systematicæ, i, 1909, No. 4, p. 101-105.*)

LÉVEILLÉ, H. . Decades plantarum novarum, XXVI. (*Repert. spec. nov., ix, 1910, p. 19-21.*)

" . Iconographie du genre *Epilobium II.* Epilobés d'Asie. (*1910, p. 69-107, with 61 plates.*)

" . *Hemibasa himalayensis* in "Decades Plantarum novarum." (*Repert. spec. nov., ix, 1911, Nos. 19-21, p. 329.*)

LUGARESI, E. . Recherches morphologiques, anatomiques et physiologiques sur le Néflier du Japon. [*Eriobotrya japonica.*] (*Thèse pour le Doct. Sci. nat. Paris. 1910.*)

LUSHINGTON, A. W. . The genus *Citrus*. (*Ind. Forest., xxxvi, 1910, p. 823-853.*)

MAYER, P. . . Systematisch-anatomische Untersuchung der *Pogostemoneæ*. (*Diss. 1909, p. 88.*)

MEBOLD, A. . . Die Vegetationsverhältnisse von Maisor. (*Jahrber. schlesisch. Ges. vat. Kult., Breslau, lxxxvii, 1910, p. 35-46.*)

MIEHE, H. . . Die sogenannten Eiweissdrüsen an den Blättern von *Ardisia crispa A.DC.* (*Ber. deutsch. bot. Ges., xxix, 9, p. 156-157.*)

MIYOSHI, M. . . Botanische studien aus den Tropen. (*Journ. coll. sc. Imp. Univ. Tokyo, xxviii, 1910, pp. 51, with 3 plates.*)

MULLER, C. . . Beiträge zur vergleichenden Anatomie der Blätter der Gattung *Agave* und ihrer Verwertung für die Unterscheidung der Arten. (*Bot. Zeit. 1, lxvii, 1909, Abt. 22, p. 93-189.*)

PELLEGRIN, F. . Sur les genres *Aglaia, Amoora* et *Lansium*. (*Notulæ Systematicæ, i, 1910, Nos. 9-10, p. 284-299.*)

PETRAK, FR. . . Uber eine neue Art der Gattung *Cirsium* aus den nordlichen Indien. (*Repert. spec. nov., ix, 1911, p. 197-199.*)

PRAIN, D. . . *Aeryma ajugiflora*. (*Hook. Ic. Plant., x, 1911, Pt. 2, Tab. 2946.*)

QUEVA, C. . . Observations anatomiques sur le *Trapa natans* L. (*Assoc. Franc. Av. Sc. Congrès de Lille, 1909, p. 512-517.*)

RENNER, O. . . Die Lithocysten der Gattung *Ficus*. (*Beih. Bot. Centralb., 1, xxv, 1910, Abt. 21, p. 183-200.*)

ROTHERT, W. . . Ueber die anatomischen Differenzen der Gattungen *Dracæna* und *Cordyline*. (*Bull. Depart. de l'Agric. Ind. néerland., 1909, p. 15.*)

SCHELLENBERG, G. . . Beiträge zur vergleichenden Anatomie und zur Systematik der Connaraceen. (*Mitt. Bot. Mus. Univ. Zurich; und Dissert. Zürich, 1910, pp. 158.*)

SEDGWICK, L. J. . . A second list of Mosses from Western India. (*Journ. Bomb. Nat. Hist. Soc., xx, 1911, No. 4, p. 1043-1045.*)

SIMMLER, G. . . Monographie der Gattung *Saponaria*. (*Denkschr. Ak. Wien, 1910, pp. 77, with 2 plates.*)

SMITH, W. W. . . Plantarum Novarum in Herbario Horti Regii Calcuttensis Cognitarum Decas. (*Journ. Asiat. Soc., Beng., vii, 1911, No. 3, p. 69-75.*)

" . . A new Gentian and two new Swertias from the East Himalaya. (*Journ. Asiat. Soc., Beng., vii, 1911, No. 3, p. 69-79, with 2 plates.*)

" . . Note on *Sterculia alata* Roxb. var. *irregularis*—a remarkable instance of leaf variation. (*Journ. Asiat. Soc., Beng., vii, 1911, No. 3, p. 85-86, with 1 plate.*)

SPRAGUE, T. A. . . *Gooringia Littledalei*. (*Hook. Ic. Plant., x, 1911, Pt. 2, Tab. 2944.*)

STADLMANN, J. . . Ein Beitrag zur Kenntnis der Gattung *Pedicularis* L. (*Jahrber. k.k. Staatsgym. im XIII Berg. in Wien, x, 1910, p. 1-7.*)

STAPF, O. . . . *Osbeckia Hildebrandii* in "Decades Kewenses." (*Kew Bull., 1911, No. 6, p. 269-270.*)

STEPHENS, E. L. . . The development of the seed coat of *Carica Papaya* L. (*Ann. Bot., xxiv, 1910, p. 607-610.*)

STIEFELHAGEN, H. . . Systematische und pflanzengeographische Studien zur Kenntnis der Gattung *Scrophularia*. (*Bot. Jahrbuch., xliv, 1910, No. 4, p. 409-496.*)

TAHARA, M. . . . Ueber die Kernteilung bei *Morus*. (*Bot. Mag. Tokyo, xxiv, 1910, p. 281-289, with 1 plate.*)

TUZSON, J. . . . Vergleichenden Anatomie der Nymphaeen. (*Math. Naturw. Ber. Ungarn., xxiv, 1909, p. 381.*)

WATT, G. . . . *Gerbera Lacei* in "Decades Kewenses." (*Kew Bull., 1911, No. 6, p. 272.*)

WENT, F. A. F. C. . . Untersuchungen ueber Podostemaceen. (*Verhand. Koninkl. Akad. Wetens. Amsterdam, xvi, 1910, No. 1, pp. 88, with 15 plates.*)

WEST, W. . . . Descriptions of three new species of *Algæ* associated with Indian Freshwater Polyzoa. (*Journ. Asiat. Soc., Beng., vii, 1911, No. 3, p. 83-84, with 1 plate.*)

WEITSTEIN, R. V. . Ueber Parthenokarpie bei *Diospyros Kaki*. (*Oest. Bot. Zeitschr., lviii, p. 457-462.*)

WILDEMAN, E. DE . . Materiaux pour une étude botanico-agronomique du genre *Coffea*. (*Ann. Jard. Bot. Buitenzorg, 3rd Suppl., 1910, p. 345-354.*)

WILLIS, J. C. . . A revised catalogue of the flowering plants and ferns of Ceylon. (*Ann. Roy. Bot. Gard. Peradeniya, iv, p. 467-510.*)

WISNIEWSKI, P. . . Ueber Induktion von Lenticellenwucherungen bei *Ficus*. (*Anz. Akad. Wiss. Krakau, Math. Nat. Kl., Serie B, 1910, 5, p. 559-567, with 2 plates.*)

YASUI, K. . . . On the life-history of *Salvinia natans*. (*Ann. Bot., xxv, 1911, 98, p. 469-483, with 3 plates.*)

YOUNG, M. S. . . The morphology of the *Podocarpineæ*. (*Bot. Gaz., v, 1910, p. 81-100, with 3 plates.*)

ECONOMIC BOTANY.

BY

ALBERT HOWARD, M.A. (CANTAB.), A.R.C.S., F.L.S.,
Imperial Economic Botanist.

AND

R. S. HOLE, F.C.H., F.L.S.,
Imperial Forest Botanist.

PART I.—AGRICULTURAL BOTANY.

In accordance with the practice of previous years this report deals only with original contributions to the Agricultural Botany of India which have been published or are in course of publication during the year under review, in this case the year ending June 30th, 1911. The

programmes of work in this subject are given in detail in the last issue of the *Proceedings of the Board of Agriculture in India* and an abstract is to be found at the end of the present volume. Under these circumstances all references to programmes have been omitted and only the results actually obtained are discussed. A list of papers published during the past year is appended.

Cotton.—Several papers on this crop have appeared during the year of which the most important are those of Leake relating to the work on cotton breeding at the Cawnpore Experiment Station. The cotton investigations in progress at this centre are concerned with the production and the subsequent introduction into general cultivation of an improved type suitable for the western cotton growing tracts of the United Provinces. The papers published during the past year give an account of the progress made up to the present time and also outline the scheme of future work. While the direct results likely to be obtained from these investigations chiefly concern the Province concerned, nevertheless both the methods adopted in the investigation and the ideas underlying the work are of much more general application and will be studied by all concerned with the improvement of cotton in India.

A popular account of this work was issued as a pamphlet at the recent Allahabad Exhibition and reprinted in the *Agricultural Journal of India*. The present cotton crop of the Western Districts of the United Provinces consists of a confused mass of types which have been referred by Gammie to a single species *Gossypium neglectum* Tod. All the forms are characterised by short and coarse lint and are entirely unsuitable for use in England or for any commercial purpose beyond the coarser kinds of cotton goods. Other forms of cotton also occur in these Provinces, but no indigenous type is met with with a silky texture suitable for spinning between 30s and 40s which it is the object of these investigations to produce. It is considered that simple selection is not likely to be of much service in finding the type required, but practical results are expected from hybridisation. In the first place the red flowered late *Nurma* cotton with long staple has been crossed with the short stapled silky form of *Bani* found in the United Provinces. In this cross the long staple and red flower of *Nurma* have been combined with the early flowering and silkiness of fibre of the *Bani*. In the second case, the long staple and red flower of *Nurma* have been united to the high lint percentage and earliness of white flowered *Desi* cotton. The reports on the fibre of the new forms are very encouraging, and in one case the sample was valued at Rs. 50

a candy more than fine Cawnpore machine ginned and was considered equal to fine Broach. Other crosses are now being made and it is hoped that these will add still further improvement. The second stage of the work after the production of an improved cotton is to introduce it into general cultivation and to maintain the quality. For this purpose a seed farm is being started near Aligarh from which it is hoped to produce enough seed to sow 1,300 acres in one year producing 500 bales (of 400 lbs.) of cotton. The cultivators growing the 1,300 acres of cotton will each year receive a fresh supply of seed from the central farm while their crop will be separately ginned and the seed distributed to a second series of cultivators controlling 20,000 acres of land under cotton. In this way it is hoped a series of waves of cotton seed emanating from the seed farm will be started which will in a short period establish the crop on a firm basis.

The student of plant breeding will find a detailed account of the Cawnpore cotton experiments in the *Journal of Genetics* (Vol. 1, page 205) while an abstract has appeared in the *Proceedings of the Royal Society*. The inheritance of several of the characters of cotton have been worked out in detail and especially the colour of the corolla, the red colouring matter of the sap, the degree of incision of the leaf, the type of branching, the length of the vegetative period and the leaf glands. Several instances of correlation of character have been observed, two of which are of great interest. The forms with a majority of sympodial secondary branches are early flowering while in those like *Nurma*, characterised by monopodial branching, the vegetative period is prolonged and no fruit is formed until the tertiary branches are developed. It is essential that plants should be of the sympodial type if their cultivation in the United Provinces is to be a commercial success, for the late flowering monopodial forms do not flower in time to give a crop before the winter sets in. At the same time the majority of Indian cottons with a valuable staple belong to the monopodial forms. It has therefore been necessary to resort to hybridisation in order to produce a new set of early flowering forms of sympodial habit, but bearing the long staple of the monopodial type. The second important correlation discussed is that between the presence of the red colouring matter of the sap and an increase in the length of the vegetative period. When the red colour is present there is a distinct retardation of the commencement of flowering.

One of the chief difficulties in the production of a new and improved type of cotton and in the maintenance of the seed supply arises from

the fact that cottons readily cross-fertilize in India as in other countries. During the preliminary breeding and selection operations it is necessary to protect the flowers from foreign pollen and to work entirely with self-fertilized seed. This circumstance adds greatly to the labour involved in the work and also entails as a preliminary the isolation of pure lines from the mass of splitting forms (which make up the bulk of the cotton crop of India) before crossing can be begun. Further an improved type will have to grow separately and every care taken to keep the seed supply pure and to prevent any degeneration taking place as a result of vicinism. These aspects of the subject have been dealt with at Cawnpore and the results incorporated in an interesting paper in the *Memoirs of the Agricultural Department of India (Botanical Series)*. During the progress of this work it was observed both in the pure types and in the crosses that some of the cultures carried on from year to year by means of self-fertilized seed exhibited varying degrees of sterility. These matters however were not for various reasons thoroughly worked out, but it is hoped that opportunity will be found to investigate them more fully in the future. As regards the method by which crossing takes place between different types of cotton, the authors consider that most of the crossing takes place between neighbouring plants and that a distance of 10 feet between the various plots is sufficient to greatly reduce if not to prevent it altogether. If these observations are found to apply to other cotton-growing tracts in India one of the difficulties in maintaining a pure seed supply for distribution to cultivators will have been removed. It is now generally recognised that the degeneration which results when improved cottons are introduced into a new country is largely a result of vicinism. The exotics in the first place are often a mixture of types which cross among each other while further degeneration results from crossing and admixture with local sorts. It is more than probable that the want of success in introducing foreign cottons into India in the past has been mainly due to natural cross-fertilization. It is possible therefore that if the work of introduction is properly carried on in the future considerable success might easily be obtained in this direction.

The shortage of cotton suitable for Lancashire has for some years past led to attempts having been made to find other supplies in the Empire and the efforts of the British Cotton Growing Association in this direction are well known. India has naturally come under notice as a possible source of supply and every effort has been made by the Agricultural Department to investigate this matter and to see how far

it is profitable for this country to supply the new demands. In connection with this a deputation of Lancashire Members of Parliament and of Indian and Lancashire Master Cotton Spinners and Manufacturers was received by the Right Honourable the Secretary of State for India in July 1910 which urged on Lord Morley the necessity of further assistance on the part of Government for the development of cotton cultivation in India. A memorandum was prepared by the Inspector-General of Agriculture in India to show what the Indian Agricultural Departments have done in the matter and to sum up the present cotton position. This paper has been published subsequently as Pusa Bulletin 26 for the information of the public and contains a detailed account of the work being done by the Agricultural Department in the various cotton tracts of India. The concluding paragraph of this bulletin sums up the subject in the following words:—

"It will be seen from what has been said above that the Agricultural Departments have devoted and are still devoting a very large amount of attention to the improvement of the Indian cotton crop. It is not therefore recommended that Government should take up any new line of work for improving its quantity or quality, but it is strongly urged that it be pointed out to the Secretary of State for India for the information of the members of the deputation that no progress in the production of finer cottons can be made until buying agencies are set up in India to buy, gin, bale and export long staple cotton where the cultivator can get a fair price at his door. This could probably be best brought about by the British Cotton Growing Association."

It is hoped therefore that the result of the deputation and of the publication of this paper will lead to the establishment by the trade of suitable buying, ginning and baling agencies in India for long staple cotton in the tracts which are found most suitable for the crop. Such agencies would be a most valuable adjunct to the seed distributing efforts of the Agricultural Department and would do much to firmly establish improved cottons in the various localities in which they can be profitably grown. An avenue is thus opened up for much valuable co-operation between the trade and the Agricultural Department by which alone it appears likely that real progress in the future will be made.

In addition to the papers referred to above the work of the Imperial Cotton Specialist is summed up in the last report of the Agricultural Research Institute, Pusa. In Madras the merits of Cambodia cotton have been referred to by Sampson and Venkayya. In the Central Provinces Clouston has dealt in detail with the development of the cotton

industry in a series of articles in the *Agricultural Gazette* published at Nagpur and has also worked out a classification of the local cottons, an account of which is now being printed.

Wheat.—Progress continues to be made in the wheat investigations in India and during the year several papers have appeared.

Evans in the Central Provinces has sent some of the best local wheats to England for milling and baking tests. Bearing in mind both the yield and the behaviour of the wheats in the mill and bakehouse, it is clear that a type superior to the soft white *Desi Pissi* of the Narbada Valley has not yet been produced at the Hoshungabad Farm. This wheat is now being grown for distribution to cultivators in a pure condition and unmixed with other sorts.

At Pusa an important stage has been reached in the wheat investigations during the year. This relates to the production of new wheats by hybridisation which combine both high yield and high quality. These have been made by crossing high yielding wheats of poor quality such as Muzaffarnagar white and Punjab type 9 with some of the moderate yielding Pusa selections characterised by grain quality equal to that of Manitoba wheat. Adopting modern methods of hybridisation, wheats were obtained in the third and fourth generation which bred absolutely true in all respects and which combined the characters of high yield and high quality. In some cases the straw was exceedingly strong and capable of supporting under Indian condition crops of 2,500 lbs. of grain to the acre. The new hybrids were milled and baked in England by Mr. Humphries, Past President of the Incorporated National Association of British and Irish Millers, who refers to them as follows:—

"The three lots, Nos. 100, 101, and 106, are very beautiful wheats also. On appearance only there is little to choose between them. If anything 106 may be the best looking. These three all behave very well indeed in the milling processes. The flours they all yield are granular, that is to say, they are bread flours rather than biscuit or pudding flours and should be judged by comparison with hard spring wheat flours from Minneapolis or Manitoba rather than by comparison with Muzaffarnagars or similar wheats. They are all flours possessing great potentialities as regards baking value, which can be developed by proper treatment during milling and baking on the special lines mentioned hereinbefore. Without this special treatment they behave very well in the dough and produce loaves of fair but not great volume and of first rate appearance and flavour. They behave like Manitoban good

grade wheats produced in a dry season. That is to say, they, like such Manitobans, respond very markedly to the addition of malt extract and 'yeast foods' and the volume of the loaf can be increased very greatly by the use of the right malt extract. They seem to be possessed of very good qualities capable under favourable conditions of yielding extremely good results."

These matters are referred to in detail in Pusa Bulletin 22 which also contains Mr. Humphries' full report and an illustration showing the actual loaves produced from an ordinary Indian wheat, an improved Pusa wheat and also one obtained from Manitoban flour. In the same paper an account of the method of growing wheat adopted at Pusa has been inserted in response to numerous requests from cultivators, planters and zemindars. The demand for the Pusa wheats has far exceeded the supply. Upwards of 1,000 acres will be sown in Behar alone during the next *rabi* season, while arrangements have been made to test these wheats on a large scale in all the important wheat-growing tracts of India.

In Pusa Bulletin 22 a preliminary account has been given of the work in progress on the production of new rust-resistant wheats by hybridisation. The Indian types differ considerably among themselves in their degree of rust resistance, but none possesses this character to the same extent as some of the rust-resistant forms met with in Europe and North America. When grown side by side in both countries the superiority in this respect of types like American Club is most marked. Attempts to cross American Club with Indian forms at Pusa so as to combine the rust resistance of the exotic parent with the qualities of the best Indian wheats failed on account of the great differences in the time of maturity and the impossibility of getting American Club to form pollen before the hot weather set in. In 1910 this obstacle was got over by growing the Indian parents at Cambridge as spring wheats and carrying out the cross-fertilization in England. This was done last year and the first generation of the hybrids was successfully grown in India during the last *rabi* season. It is now hoped that in a short time real rust-resistant wheats will be available in India.

Fibres.—Several papers on Indian fibre crops have appeared during the year, while others are in the press.

At Pusa the results of a study of patwa (*Hibiscus cannabinus*) and of rozelle (*Hibiscus Sabdariffa*) have been published. Eight types of *Hibiscus cannabinus* belonging to five varieties have been isolated and

their characteristics worked out in detail. As fibre producers they differ considerably while all the types readily cross-fertilize with each other. The effects of vicinism can however be entirely prevented by rogueing the plots during the seedling and early vegetative stages. This enables the method of selection by pure line cultures, ordinarily restricted to self-fertilized plants, to be extended to a crop in which natural crossing is common. Possibly the removal of aberrant plants in this way before flowering takes place can be extended to cotton and other crops in which improved sorts are liable to rapid degeneration as a result of vicinism. In *H. Sabdariffa* four varieties almost identical in all other respects except in the distribution of colour have been isolated. In consequence of a slight difference in the floral arrangements the flowers of this species are self-pollinated and no natural crossing between the varieties when allowed to flower freely has been so far observed at Pusa.

The Fibre Expert to the Government of Eastern Bengal and Assam has summed up his work during the year in the *Agricultural Journal of India*. The classification of the various varieties of jute has been completed and pure types are now available for further study. The flowers of all are said to be normally self-fertilized in which case the selection of single plants will be possible in this crop. Cross-fertilization experiments are also in progress which have been designed to throw light on the origin of the different colour types of plant. The detailed results of the cross-fertilization experiments and on the methods of pollination in this crop are in the press.

The flax experiments at Dooriah in Behar which are concerned with the production of fibre suitable for export to Europe have been summed up by Vanderkerkhove in Pusa Bulletin No. 25 to which an introduction has been contributed by the Inspector-General of Agriculture. During the season of 1909-10 an area of 60 bighas was sown at Dooriah and the crop converted into fibre from which a profit of Rs. 61 per acre is expected. These investigations are being carried out under the supervision of the Behar Planters' Association by means of a joint subsidy from the Imperial and Bengal Departments of Agriculture. The work is being continued and will no doubt be followed closely by all interested in planting enterprise in Behar.

Plant breeding.—An important publication of considerable interest to workers in Agricultural Botany in India has been undertaken during the year and is now in the press. This is Vol. V of *Die Züchtung der landw. Kulturpflanzen* edited by Professor Dr. C. Fruwirth of Vienna

and published by Messrs. Paul Parey of Berlin. The new volume of this important work deals with the breeding of tropical plants and it is expected that its publication will do much to stimulate research work on sound lines on the crops of the torrid zone. The article on cotton has been contributed by the Economic Botanist to the Government of the United Provinces, while papers on the following crops have been prepared at Pusa:—Til (*Sesamum indicum*), jute (*Corchorus capsularis* and *C. olitoris*), patwa (*Hibiscus cannabinus*), roselle (*Hibiscus Sabdariffa*) and sann (*Crotalaria juncea*).

The results of the earlier work at Pusa on the economic significance of natural cross-fertilization in India, which were referred to in last year's report, were published during the year. During the current year this work has been continued and will be published as opportunity offers. It is now being recognised in India that a detailed study of the methods of pollination in any crop should precede all attempts at improvement and that this knowledge is essential in all schemes of seed distribution.

Miscellaneous.—Gammie has published a paper on the millets of the genus *Setaria* in the Bombay Presidency and Sind in which the various cultivated forms are described and figured. In the *Agricultural Ledger* a bulky compilation arranged alphabetically under the vernacular names dealing with the literature on the races of rice in India has been published as well as a paper on the soy bean in India by Hooper.

PART II.—FOREST BOTANY.

A.—Work done by Forest Botanist.

Research work.

The research work of the Forest Botanist falls under two main heads which may be shortly defined as follows:—

(*i*) The study of the physiology and ecology of our important forest species, with special reference to the factors which determine their natural distribution and which are responsible for their most important diseases.

(*ii*) The detailed systematic study and description of those forms of forest plants of considerable economic importance of which the existing classification is unsatisfactory and for the adequate treatment of which field-study is essential.

As regards sub-head (*i*) it is recognised that, in a large number of cases, such factors as soil-aeration, soil-moisture, temperature, light, and soil-composition are primarily responsible for the diseases and un-

satisfactory growth of our forest plants and that for thoroughly efficient forest-management it is essential to acquire a precise knowledge of the degree of intensity at which such factors first begin to cause disease and at which they must in consequence be considered to be injurious.

Ecology of sal.

Attention is at present being chiefly paid to the factors primarily affecting the healthy development of sal and particularly to those factors which cause the dying-back of seedlings. The preliminary work done up to date shows that, altogether apart from damage by frost, in the local climate of Debra Dun and in soil similar to that on which most of the local sal forests occur—

(*a*) a large proportion (73 per cent.) of sal seedlings died down from September-June when not watered; of those seedlings growing under similar conditions, with the only exception that they were lightly watered, only 41 per cent. died back, and of those plants which, in addition to being lightly watered, were also shaded only 16 per cent. died back.

(*b*) Sal seedlings developed more successfully [as judged independently by (1) the number of stems which died back and (2) the dry weight of the best stems which survived] when provided with overhead shade and diffuse lateral illumination, than when grown in the open with no shade and watered.

(*c*) Sal is sensitive as regards soil-aeration and water-logging soon proves fatal.

(*d*) The factor of primary importance influencing the establishment and development of sal seedlings appears to be undoubtedly the water-content of the soil. Light is also a factor of great importance, but it has not yet been determined how far the favourable results obtained by shading can be ascribed to the decreased intensity of light, and to what extent they are due to the increased soil-moisture content.

Compared with these two factors the chemical and physical characteristics of the soil appear to be of minor importance.

The preliminary work done up to date is now being prepared for publication and arrangements have been made for the continuation and extension of the experiments with the object of determining instrumentally and accurately the precise intensity of each individual factor

of primary importance which in itself alone suffices to cause the unsatisfactory growth or disease of sal. Once this has been done it will obviously be possible to determine, in the case of any particular forest, whether the absence of sal reproduction there, or the unsatisfactory growth of sal, is, or is not, due to these factors, and this knowledge will indicate the best measures to be adopted for the improvement of the growth.

Ecology of grasses of sal forests.

The memoir on the ecology of forest grasses embodying the results of the work done up to date which was mentioned in last year's report was still in the press at the close of the year, owing to sanction for the publication having been delayed. The ecological study of grasses of sal forests is being continued with the principal object of determining the best treatment to adopt in each case with the object of improving the fodder supply and of facilitating afforestation respectively.

Information is also being collected regarding the grasslands situated in all the Government forests of the United Provinces, the present method of treatment of the same, the species which are dominant in each, the approximate area occupied by each species, its average yield expressed in weight of air-dried grass per acre and its local economic uses. This information will indicate the extent to which the results obtained from detailed work in Dehra Dun, regarding the most suitable method of treatment, are applicable to other forest-grasslands which are approximately of the same type and will also indicate which areas require separate study. Advantage is being taken of the presence of Mr. William Raitt, paper expert, at Dehra Dun to obtain analyses of each species indicating its value for the manufacture of paper-pulp. The results obtained will, it is hoped, be sufficiently complete for publication next year.

Trametes Pini.

Extensive damage by the fungus *Trametes Pini* in the forests of *Pinus excelsa* having been reported in the Simla and Bashahr Forest Divisions, the Forest Botanist visited these forests in May and June of the year under report. It had been ascertained that infection could, in some cases at least, be conveyed through the roots from a diseased to a healthy tree. This mode of infection, if found to be frequent, would obviously greatly increase the difficulties in the way of combating the pest and hence it was desirable to determine how infection was chiefly conveyed from diseased to healthy areas. Study in the

field indicated that the spread of the disease was mainly due to wind-carried spores, the fungus usually gaining access to a healthy tree through the stumps of cut or broken branches. Hence preventive measures in the way of stopping lopping and destroying the sporophores are likely to be effective. The results of the investigation are being prepared for publication and the study will be continued.

Taxonomic work.

As regards work done under sub-head (ii) the herbarium material of the genus *Grewia* available at Kew and the British Museum, as well as Jussieu's types at Paris, were examined by the Botanist during the year. Some doubtful points were thus settled and the work is being prepared for publication. Recent work of European botanists has shown that there is more than one species of Indian *Xylia*. It is known that the wood of *pyinkado* varies considerably in quality, but it is not known how far this variation depends on the species or how far the *pyinkado* of commerce is obtained from *Xylia dolabriformis*. Specimens of *Xylia* have therefore been asked for from all forest divisions where the genus is known to occur with a view to determining the distribution and wood characters of the different species. The study of the genus *Saccharum* has shown that the valuable *Saccharum Munja* Roxb. is really a distinct species from the comparatively unimportant *Saccharum arundinaceum* Retz with which it is often confused, that *Saccharum porphyrocomum* Hackel is really identical with *Saccharum Narenga* Wall. and that *Erianthus Griffithii* Hook. f., being founded partly on *Saccharum Griffithii* Munro and partly on *Erianthus Ravennæ* Beauv., cannot be maintained. These results are included in the memoir now in the press.

B.—Work done by others.

Raising of tree stems during natural development.

Some years ago forest officers in Madras reported that permanent marks placed on teak stems in the Nilambur plantation were found in course of time to alter their position and to rise above their original level. An experiment to determine this point is being carried out by the local officers on the lines suggested by the Forest Botanist and a report embodying the first set of observations was received during the year. Thirty-one trees were selected and carefully marked in Nilambur plantation in December 1909, the levels of the marks on the stems with reference to permanent bench marks being carefully taken with a Y level and recorded. The levels of these marks were again taken on April 8th, 1911, and the results compared. Observations must be continued for several years before the results can be regarded as at all final,

but the observations made up to date show that, out of 31 trees, 23 showed an appreciable rise, amounting in some cases to nearly ¾ of an inch in a little more than 1 year, 2 trees showed no change and 6 showed a slight sinking. Thus there seems to be some support for the theory that teak trees are actually raised above their original position in the normal process of development.

Taxonomic work.

Mr. H. H. Haines published his *Forest Flora of Chota Nagpur*, Rai Bahadur Upendranath Kanjilal published his *Forest Flora of the Siwalik and Jaunsar Divisions*, and Mr. W. F. Bisco his *Trees and Shrubs of the Indore State*.

A collection of the plants in the Sind Forest Circle has been commenced with the object of forming a local forest herbarium.

List of papers on Economic Botany published during the year ending June 30th, 1911.

Anstead, R. D. . . Para rubber seed oil and Peanut. [*The Planters' Chronicle* (*Bangalore*), *vi*, *122*, *1911*.]

Aubert, L. . . *Andropogon Sorghum*: Millet or pyaung: its cultivation and some of its enemies. (*Agr. Jour. of India*, *v*, *222*, *1910*.)

Barber, C. A. . . The influence of environment on plants. (*Jour. of the South Indian Association*, *i*, *249*, *1911*.)

Bisco, W. F. . . Trees and Shrubs of the Indore State. (*Bombay*, *1910*.)

Bhutu-Tucker, F. . Memorandum regarding leading Eucalypts suitable for India. (*Bull. 21*, *Agr. Res. Inst.*, *Pusa*, *1910*.)

Brown, W. Robertson. Peach growing around Peshawar. (*Agr. Jour. of India*, *vi*, *14*, *1911*.)

Burkill, I. H. . . Literature on the races of rice in India. (*Agr. Ledger*, *No. 1*, *1910*.)

Burns, W. . . The Pairi mango. (*Agr. Jour. of India*, *vi*, *27*, *1911*.)

Burns, W. . . Annual reports of the Bassein and Ganeshkhind Botanical Gardens, 1909-10.

Clouston, D. . . Cotton cultivation in the Central Provinces. [*Agr. Gazette* (*Nagpur*), *vi*, *Nos. 9*, *10 and 11*, *1910*, *and vii*, *No. 2*, *1911*.]

COVENTRY, B. . . Report on the progress of Agriculture in India for 1909-10, Calcutta, 1911.

COVENTRY, B. . . Note on the present position of cotton investigation in India. (*Bull. 26, Agr. Res. Inst., Pusa, 1911.*)

EVANS, G. . . . The improvement in the quality of wheat exported from the Central Provinces. (*Bull. No. 4, Cent. Prov. Agr. Dept., 1910.*)

FINLOW, R. S. . . Report on jute and flax experiments during the past year. (*Agr. Jour. of India, vi, 70, 1911.*)

GAMMIE, G. A. . . Caravonica cotton. (*Agr. Jour. of India, v, 249, 1910.*)

GAMMIE, G. A. . . Report of the Imperial Cotton Specialist. (*Report of the Agr. Res. Inst., Pusa, 1909-10.*)

GAMMIE, G. A. . . Millets of the genus *Setaria* in the Bombay Presidency and Sind. [*Mem. Dept. Agr. of India (Botanical Series), iv, No. 1, 1911.*]

GAMMIE, G. A. . . The present position and prospects of cotton cultivation in India. (*Agr. Jour. of India, v, 335, 1910, and vi, 40, 1911.*)

HENDERSON, G. S. . Exotic cottons in Sind. (*Agr. Jour. of India, vi, 131, 1911.*)

HOOPER, D. . . *Glycine hispida* (soy bean). (*Agr. Ledger, No. 3, 1911.*)

HOOPER, D. . . The composition of Indian Yams. [*Jour. and Proc. Asiatic Soc. Bengal (New Series), vii, 67, 1911.*]

HOWARD, A. . . Suggestions for the development of the Hop Industry in Kashmir. Kashmir and Jammu State, 1910.

HOWARD, A., & HOWARD, G. L. C. Studies in Indian Fibre Plants, No. 2. On some new varieties of *Hibiscus cannabinus* and *Hibiscus Sabdariffa*. [*Mem. of the Dept. of Agr. of India (Botanical Series), vi, No. 2, 1911.*]

HOWARD, A., & HOWARD, G. L. C. The milling and baking qualities of Indian wheats, No. 3. Some new Pusa hybrids tested in 1910. (*Bull. 22, Agr. Res. Inst., Pusa, 1911.*)

HOWARD, A., HOWARD, G. L. C., & ABDUR RAHMAN KHAN. The Economic Significance of natural cross-fertilization in India. [*Mem. of the Dept. of Agr. in India (Botanical Series), iii, No. 6, 1910.*]

KANJILAL, U. . . Forest Flora of the Siwalik and Jaunsar Forest Divisions. (*Calcutta, 1911.*)

KULKARNI, L. B. . The cultivation of guavas near Poona, Dharwar and Limboga. (*Bull. 40, Bombay Agr. Dept., 1911.*)

LEAKE, H. M. . . Studies in Indian cotton. (*Jour. of Genetics, i, 1911, 205.*)

LEAKE, H. M. . . Experimental studies in Indian cotton. (*Proc. Roy. Soc., B., vol. 83, 447, 1911.*)

LEAKE, H. M., & PARR, A. E. The problem of improvement of cotton in the United Provinces of Agra and Oudh. (*Agr. Jour. of India, vi, No. 1, 1911.*)

LEAKE, H. M., & RAM PERSHAD. Notes on the incidence and effect of sterility and of cross-fertilization in the Indian cottons [*Mem. Dept. of Agr., India (Botanical Series), iv, No. 2, 1911.*]

MEHTA, G. D. . . An examination of the seed supply of the Broach District. [*Bull. 37 (1910) and 43 (1911), Bombay Agr. Dept.*]

SAWYER, A. M. . The Shonk-noo. (*Citrus Hystrix* DC.). (*Agr. Jour. of India, v, 331, 1910.*)

TROUP, R. S., & KANJILAL, U. *Canallia integerrima*. (*Indian Forester, xxxvi, p. 578.*)

VANDEKERKHOVE, M. E. Report on the Flax Experiments conducted at Dooriah during the year 1910-11. (*Bull. 25, Agr. Res. Ins., Pusa, 1911.*)

VENKAYYA, P. . . Cambodia cotton in India. (*Agr. Jour. of India, vi, 160, 1911.*)

WILSON, J. . . Memorandum on Indian wheat for the English market. (*Bull. 20, Agr. Res. Ins., Pusa, 1910.*)

WOODHOUSE, E. J. . Some suggestions as to the organisation of Agricultural Exhibits in Bengal. (*Record No. 1 of 1910, Dept. of Agr., Bengal.*)

WOODHOUSE, E. J. . A note on the value of green-manuring and summer fallows. (*Bengal Quarterly Jour. of Agr., iv, No. 1, 1910.*)

MYCOLOGY.

BY

E. J. BUTLER, M.B., F.L.S.,
Imperial Mycologist.

I.—Plant Pathology.

Palm diseases.—Two papers of considerable length on the diseases of palms appeared during the year. Dr. L. C. Coleman published an account of the Areca palm disease known as *koleroga*, in the Bulletins of the Agricultural Department, Mysore. The fungus which causes this disease was first seen by the writer in 1903, and identified, in a paper published in 1907, as *Phytophthora* (?) *omnivora* de Bary. Dr. Coleman, while still including it in the probably composite species, *Phytophthora omnivora*, makes a distinct variety, *Areca*, for it. Its hosts are *Areca Catechu*, *Cereus formosus*, *Clarkia elegans*, *Schizanthus wisetonensis*, *Oenothera biennis*, *Salpiglossus variabilis*, *Solanum melongena* and *Lycopersicum esculentum*. A closely allied species occurs on Cacao in Ceylon and other parts of the tropics, and is capable of attacking nearly all the above hosts. As a result of a thorough comparison of the two forms in artificial cultures, Dr. Coleman concluded that they are distinct species and named the Cacao fungus *Phytophthora Theobromæ*. It was, however, named *Phytophthora Faberi* by Maublanc, prior to the publication of Dr. Coleman's paper, and the latter name must stand. A very full account is given by the author of the characters and biology of the Areca parasite and of the remedial measures carried out by him to reduce the losses, estimated at 3 to 4 lakhs of rupees annually, caused by the disease in Mysore. A single spraying with Bordeaux mixture, applied just before the break of the monsoon, was found to be effective in saving a large proportion of the nuts. The cost is well within the means of the arecanut growers. Further experiments are being carried out to test the relative efficiency of various methods of spraying. An abridgment of the bulletin was published in the *Annales Mycologici*.

The bud-rot of palms in Madras Presidency was described by the writer in a memoir published early in the year. The disease has been under observation since 1905, and an extensive campaign to check its spread and stamp it out was started by the writer, with funds and assistance provided by the Madras Government, in 1907. Since 1910

the work has been in the hands of the recently appointed Madras Mycologist, Mr. McRae. The memoir includes a description of the area affected by the disease, an account of its first appearance and spread, the species of palms affected (including palmyra, cocoanut and areca), a full description of the fungus, *Pythium palmivorum*, which is its cause, and a discussion of the operations to check it carried out by Government. The conclusions arrived at are that these operations have been entirely successful in limiting the disease in Godavari district to the area previously infected; it is hoped that they will prove equally effective in Kistna district, where they were started late. This alone should fully justify their cost. At the time the memoir was written it was not easy to determine what effect the previous work had had in reducing the intensity of the disease within the infected area, but further records during the past year tend to show that the steady removal of infected trees is bearing fruit in a diminution of the number of new infections. The operations are being continued and it is anticipated that if the disease can be kept confined within its present limits, it will eventually be possible to stamp it out completely.

Ginger disease.—An account of the soft rot of ginger was written by Mr. McRae for the Agricultural Journal of India. This disease is prevalent in Eastern Bengal, Gujarat and probably elsewhere. In Rangpur the loss in damp soils is 10 to 15 per cent. of the crop; in bad years almost the whole may be lost. The cause appears to be the attack of a fungus (*Pythium gracile*) on the rhizomes and base of the plant. As a result of experiments carried out at Burirhat farm in 1908-09, Mr. McRae was in a position to recommend effective measures for checking the disease.

Turmeric disease.—The writer described a leaf disease of turmeric, found all over Northern India, in the *Annales Mycologici*. It is caused by a previously undescribed species of *Taphrina* which, while not very destructive, is probably responsible for a greater reduction of the yield than the cultivators themselves suspect. No treatment can be recommended as yet.

Tea diseases.—A parasite of the tea bush, *Laestadia Theae*, found in Java some 12 years ago but not previously recorded in India, was reported from the Dooars in 1910. It causes a leaf disease known as copper-blight, which spreads with great rapidity under suitable weather conditions. A note describing its characters was written by Mr. Shaw for the *Agricultural Journal*. The writer investigated a disease of tea seed, known for many years in Assam to cause considerable loss in

certain tea-seed gardens. Acting on a suggestion made by the officers of the Scientific Department of the Indian Tea Association, a good deal of evidence was obtained indicating that the disease is due to the tea seed bug, *Pœcilocoris latus*. This insect punctures the seed and sucks the juices. Through the opening thus made fungi are able to enter, and the subsequent injury to the seed is due to the growth of one or other of several species of rot-producing fungi at the expense of the seed tissues. It has long been a pathological puzzle how the fungi which are often found within hard-shelled seeds, such as the walnut, have been able to effect an entry; possibly the explanation in these cases will be found to be similar to that of the tea-seed fungus. The Indian Tea Association are issuing a pamphlet on the subject. As a result of the extension of blister-blight in India, mentioned in last year's report, some countries have insisted on the disinfection of all Indian tea seed exported to them. The writer was asked to advise on the subject and recommended steeping in formalin, which has been adopted. It is a matter for congratulation that the Indian Tea Association have decided to strengthen their Scientific Department by the addition of a Mycologist, as the fungus diseases of tea are growing in importance.

Forest tree diseases.—As usual the Forest Department referred a certain number of diseases of trees for investigation in the Mycological Laboratory at Pusa. The chief result was a paper on the root infection of the blue pine by *Trametes Pini*, a fungus which is causing considerable damage in the Simla Hill forests, by A. Hafiz Khan. This fungus was hitherto believed to be able to attack trees through above ground wounds only. A second method of infection was shown to occur below ground, through roots of diseased trees coming into contact with those of healthy ones. Mr. Anstead, Planting Expert to the United Planters' Association of Southern India, has described in the *Planters' Chronicle* the results of experiments conducted in Cochin to prevent the attacks of "pink disease" of rubber trees, caused by the fungus *Corticium javanicum*. Over two hundred thousand Para trees were treated with Bordeaux mixture, with most encouraging results. One estate reported that the disease had been diminished by 75 per cent. and the Manager believes that if every tree were done properly the disease would disappear. The mixture, made up of 6 lbs. copper sulphate, 4 lbs. quicklime and 45 gallons water, with a locally prepared paste or resin or jaggery added to improve its adhesive properties, is brushed on the trees near the forks and over wounds. The cost is very little, only Re. 1 to Rs. 2 per acre. As this is by far the worst disease of rubber trees in South India such results are very gratifying.

Fruit diseases.—The principal work on fruit diseases published during the year was Mr. Burns' bulletin on grape-vine mildew in Bombay Presidency. In this the occurrence of the disease at Nasik and near Poona is described and the results of experiments in its control, carried on under Mr. Burns' direction by his assistants and the owners of the vineyards, are given. Spraying with Bordeaux mixture, to which soft soap was added as an adhesive, was found to reduce the damage considerably. The 6-4-50 formula was used, except when actually spraying the bunches of fruit, when half strength was employed. The results were satisfactory when the work was carefully carried out between Mid-December and Mid-February, the critical period of the year for the disease in this district. Mr. Basu, Assistant Professor of Mycology at the Bengal Agricultural College, investigated a disease of plantains at Chinsurah, and wrote a note describing it in the *Bengal Quarterly Agricultural Journal*. The disease appears to be caused by a species of *Fusarium*, but further work is necessary to establish this.

Miscellaneous.—Experiments carried out at Pusa, and independently by the Mycological Assistant of the Bombay Department of Agriculture at Poona, have demonstrated that the fungus which causes pigeon-pea wilt produces its spores freely on the stems of diseased plants. Hence in addition to soil infection from previously diseased crops, air-borne infection is also possible. Work on sugarcane diseases is in progress at Pusa, Sabour and Poona, but has not yet yielded results to justify publication. Mr. Shaw of Pusa has a large investigation in hand on the root-rot of a number of cultivated plants, caused by a species of *Rhizoctonia*. The results are not yet ripe for publication. Most of the experimental and demonstration work in treating plant diseases, mentioned in last year's report as being in progress at various farms of the Provincial Departments of Agriculture, has been continued.

For some years black spore-like bodies have been observed as impurities in samples of "Indian" rice flour, examined in the Laboratory of Agricultural Chemistry of the Royal Agricultural College, Berlin. Specimens of these sent to the writer enabled him to identify them as the spores of the rice bunt, *Tilletia horrida*. This fungus was hitherto known to occur only in Japan and the United States; it appeared unlikely that its presence in India proper could have escaped detection: the Berlin authorities were therefore asked to ascertain the exact origin of the rice containing the impurity. The results of the investigation were published by Herr P. Filter in the *Centralblatt für Bakteriologie* recently. The rice containing this fungus was found to have been

imported from Siam, Moulmein and Bassein. We may conclude, therefore, that rice hunt occurs in Siam and Burma and is either restricted to these countries by climatic conditions or, more probably, is spreading from a centre in Eastern Asia and will eventually reach India proper.

II.—Systematic Mycology.

A new genus of the *Uredinaceæ* was described by the writer in the *Annales Mycologici*. It was collected on *Olea dioica* in the Deccan and is of considerable taxonomic interest.

A collection of fungi, chiefly *Agaricaceæ*, made by the Rev. Father Blatter in Bombay and Dehra Dun, was described by the Rev. F. Theissen, S.J., in the *Annales Mycologici*. Two new species of the Uredinaceous genus *Phakopsora* were described by Dr. P. Dietel and three new species of smuts by Herren H. and P. Sydow from Indian material supplied by the writer. One of the latter is of economic interest as a parasite of *Panicum frumentaceum*, one of the cultivated millets of India. Notes on the rare genus *Pucciniostele*, based on Himalayan specimens sent by the writer, were included in a paper by Dr. P. Dietel on Japanese *Uredinaceæ*. Mr. Massee has described two new species of fungi which attack wood and also a new species of edible truffle from the United Provinces.

The large collections of Ascomycetous fungi in the Pusa Herbarium were worked through by the writer; annotated lists, prepared in collaboration with Herren H. and P. Sydow of Berlin, are in the press. A description of a remarkable aquatic fungus found at Pusa will also appear shortly.

List of Publications.

Ainstrak, R. . .	Pink disease of Para Rubber and Bordeaux Mixture. (*Planters' Chronicle, v, No. 18, 1910, and vi, No. 8, 1911.*)
Basu, S. K. . .	Report on Banana Disease of Chinsurah. (*Quarterly Journal, Dept. of Agric., Bengal, ix, No. 4, p. 196, 1911.*)
Burns, W. . .	First Experiments in treatment of Grape Vine Mildew in Bombay Presidency. (*Dept. of Agric., Bombay, Bull. No. 36, 1910.*)
Butler, E. J. .	The Bud-rot of Palms in India. (*Mem. Dept. of Agric. in India, Bot. Ser., iii, No. 5, 1910.*)

BUTLER, E. J. . A new genus of the *Uredinaceæ*. (*Annales Mycologici, viii, p. 444, 1910.*)

BUTLER, E. J. . The leaf spot of Turmeric (*Taphrina maculans* sp. nov). (*Annales Mycologici, ix, p. 36, 1911.*)

COLEMAN, L. C. . Diseases of the Areca palm: I. Koleroga. (*Bull. No. II, Mycol. Ser., Dept. of Agric., Mysore State, 1910, and Annales Mycologici, viii, p. 591, 1910.*)

DIETEL, P. . . Uredineen aus Japan: III. (*Annales Mycologici, viii, p. 304, 1910.*)

DIETEL, P. . . Zwei neue Arten der Gattung Phakopsora. (*Annales Mycologici, viii, p. 469, 1910.*)

FILTER, P. . . Ueber das Vorkommen von Tilletia horrida Takahashi in Reisfuttermehlen. (*Centralbl. für Bakter. Parasitenk. u. Infektionskr., 2nd Ab., xxix, p. 342, 1911.*)

HAFIZ KHAN, A. . Root infection of *Trametes Pini*. (*Ind. For., Oct. 1910.*)

MCRAE, W. . . Soft rot of Ginger in the Rangpur District, Eastern Bengal. (*Agric. Journ. Ind., vi, p. 130, 1911.*)

MASSEE, G. . . Fungi exotici. (*Kew Bull., 1910, No. 7, p. 249.*)

SHAW, F. J. F. . Copper blight of Tea. (*Agric. Journ. Ind., vi, p. 78, 1911.*)

SYDOW, H. & P. . Novæ Fungorum species. (*Annales Mycologici, ix, No. 2, March 1911.*)

THEISSEN, F. . . Fungi aliquot Bombayenses a Rev. Ed. Blatter collecti. (*Annales Mycologici, ix, No. 2, March 1911.*)

SYLVICULTURE.

BY

R. S. TROUP, F.C.H.,

Sylviculturist.

Considerable progress was made during the year in the establishment and measurement of permanent sample-plots for ascertaining the increment of typical woods in girth, height and volume: 29 sample-plots were laid out by the Sylviculturist, these being distributed in the Siwalik, Naini Tal, Haldwani, Pilibhit and Gonda Divisions, and dealing chiefly with *Shorea robusta* (*sál*), *Dalbergia Sissoo*, *Acacia Catechu*, and *Quercus incana*. In addition numerous measurements of typical *sál* coppice areas and *Pinus longifolia* crops were carried out; in such cases permanent demarcation was not necessary, since the ages of the crops were ascertainable. The system employed for estimating the volume of the crops measured is that known as the method of sample-trees by groups. Subsequent re-measurements of the permanent sample-plots will be quinquennial. In several cases adjoining thinned and unthinned plots were laid out in order to ascertain the degree of density required to produce the maximum volume increment per acre under different conditions. It is expected that the establishment of similar sample-plots will be completed in the United Provinces during the year 1911-12, and in subsequent years the work will be continued in other Provinces, those which contain *sál* forests being dealt with first.

Measurements in sample-plots.

2. In the Gonda Forest Division of the United Provinces experimental plots were laid out by the Sylviculturist with a view to testing the respective merits of cutting *sál* coppice flush with the ground and at a height of a few inches from ground level. Similar experimental plots laid out by the Divisional Forest Officer in the Gorakhpur Division during the past two years were also visited. It will be some years before conclusive results are arrived at, though the Gorakhpur experiments tend to show that the development of *sál* coppice shoots in early life is somewhat better as a result of cutting some inches from the ground, than where the stumps are trimmed flush with the ground. In the Gorakhpur Division it was proved beyond a doubt some years ago that under certain

The cutting of *sal* coppice.

conditions the high cutting of *sál* coppice gave better results than cutting at ground level. This was particularly the case in dry hot localities where the stumps, whether cut high or low, died down for a distance of some inches below the cut surface; consequently where the coppice was cut high the base of the stump at ground level remained alive even when the top part dried up, whereas in the case of low cutting the whole stump was liable to dry up for some inches below ground level, being thus rendered incapable of producing coppice shoots. It still remains to be proved whether or not the high cutting of *sál* coppice is advantageous under all conditions.

Causes and effects of drought in *sal* forests in Oudh.

3. The effects of the great drought of 1907 and 1908 on the *sál* forests of Oudh continued to be studied during the year, affected areas in the Gonda, Gorakhpur and Pilibhit Divisions being visited. So far as observations go at present, it appears doubtful if any satisfactory preventive measures for future damage by drought will be practicable, though something might be done in the way of maintaining a liberal proportion of drought-resisting species in areas liable to be affected, as well as adopting a system of management involving the least possible risk of permanent damage. It was noticed in this connection that the standards in coppice-with-standards as a rule suffered more than trees in high forest. As regards the effect of the drought on different species, it is noteworthy that as a general rule the more shallow-rooted species suffered less than the deep-rooted species, the explanation no doubt being that the latter drew their water-supply from moist substrata which became dried up with the lowering of the water-level consequent on the drought, whereas the surface-feeders were habituated to the annual drying up of the upper layers of the soil, and were therefore less liable to suffer from any abnormal drought. The *sál* appeared to suffer more than any other tree, while among the most conspicuous drought-resisting species were *Ficus religiosa*, *F. bengalensis*, *Miliusa velutina*, *Stereospermum suaveolens*, and *Mallotus philippinensis*. The damage done by the drought tended to be greater on sandy subsoils than on subsoils with a fair admixture of clay, owing to the inability of the former to retain sufficient moisture, through lack of retentive power when the water-level sank.

Developments in sylvicultural systems:
(1) Haldwani Division *sal* forests.

4. Progress continues to be made in the application of the system of successive regeneration fellings to *sál* forests, the preliminary working-plan report for the forests of the Haldwani Division, United

Provinces, containing some important prescriptions in this respect. The rotation proposed is 150 years, subject to a possible reduction, this being divided into 5 regeneration periods of 30 years each. Some difficulty is anticipated in the allotment of the various crops to the different periods owing to their present irregular state, and some initial sacrifice is inevitable. The compartment being the unit of area for regeneration purposes, and the crops over whole compartments probably in no case being uniform in age, it remains to ascertain approximately the dominant age throughout each compartment, which will then be allotted to its period on this basis within fairly wide limits. Linear valuation surveys will be carried out where necessary to aid in this allotment.

(2) Thano sal forest.

5. The working-plan for the Thano *sál* forest, Dehra Dun, alluded to in last year's report, was finally sanctioned during the year. Under this plan the forest will be treated experimentally under the system of successive fellings, the rotation being 144 years, divided into 6 periods of 24 years each. Reproduction being already well established in the first periodic block, preparatory and seeding fellings are not necessary, and there will therefore be only two regeneration fellings, a secondary and a final felling, the one following the other after an interval of 12 years.

Working of bamboos.

6. Two experimental plots, one in the Siwalik Forest Division and the other in the Lansdowne Forest Division of the United Provinces, were laid out during the year, with a view to ascertaining the best methods of cutting and working bamboos (*Dendrocalamus strictus*), a subject on which opinions differ somewhat at present. It may be some years before any conclusive results are arrived at, but it is hoped that something may be learned which will lead to practical results bearing on the systematic working of bamboo forests.

Hardwickia binata.

7. An important contribution to the literature on *Hardwickia binata*, by Mr. D. O. Witt, was published during the year in the *Indian Forest Records*: the development of the tree from the seedling to the mature stage is traced with the aid of a series of good diagrams and photographs, and its various sylvicultural requirements are dealt with in detail.

Santalum album.

8. In the same publication Rao Sahib M. Rama Rao publishes the results of a series of experiments tending to show that the artificial propagation of sandal can be more successfully and economically carried out by *in situ* sowings than by the transplanting of nursery-raised plants, one of the most

important advantages of the former being the freedom from damage to the roots and root attachments of the seedlings and their hosts.

List of Indian Publications, 1910-11.

Best, J. W. .	. Working-plan for the Government forests of the Bhandara Division, Southern Circle, Central Provinces.
Cavendish, F. H.	. Working-plan for the Jokai Reserve of the Lakhimpur Division, Eastern Circle, Eastern Bengal and Assam.
Comber, E. R. .	. Working-plan for the Reserved forests in the Sambalpur Division, Bengal.
Copeland, D. P.	. Working-plan for the Kamrup Sál Reserves, Western Circle, Eastern Bengal and Assam.
Hopwood, J. C.	. Working-plan for the Nwa Working Circle, Myittha Division, Northern Circle, Burma.
Kanjilal, Upendra-nath.	Working-plan for the Holongapar Reserve, Sibsagar Division, Eastern Circle, Eastern Bengal and Assam.
Leete, F. A.	. Memorandum on Teak Plantations in Burma. (*For. Bull. No. 2, 1911.*)
Rama Rao, M.	. Notes on Sandal. (*Ind. For. Rec., ii, Part III.*)
Rogers, C. G.	. The Raising of Forests with Field Crops in Berar. (*Ind. For., xxxvii, 8.*)
Smythies, E. A.	. Some Aspects of Fire Protection in Chir Forests. (*Pinus longifolia*). (*Ind. For., xxxvii, 64.*)
Troup, R. S. .	. Tables for the Volume Measurement of Sample-Plots.
Witt, D. O. .	. The Sylviculture of *Hardwickia binata*. (*Ind. For. Rec., ii, Part III.*)

ECONOMIC FOREST PRODUCTS.

BY

A. RODGER,

Forest Economist.

1. **Economic museum.**—Work in this museum continued during the year, many new specimens of much interest being added. The museum dates from 1881, having been started by Sir Dietrich Brandis.

but it was largely added to and improved by Mr. Gamble when Director of the Forest School. Mr. Gamble was, by the way, never Deputy Director as stated in last year's report. A large collection of economic products of all kinds was received from the United Provinces Exhibition at Allahabad through the kindness of the United Provinces Government and the exhibitors, but these cannot be properly displayed until the new institute buildings are completed.

2. Testing of *sal* and teak.—*Sál* logs grown in various localities, hills and plains, high forest and coppice, and teak logs grown in plantations and adjoining natural forest in Burma were received, and beams and blocks prepared for testing and comparison. Splitting tests were carried out with *sál*, and a series of tests with teak grown in plantations and natural forests in Burma were undertaken at Sibpur. As however the trees did not grow under the same conditions of elevation and soil, further tests will be carried out with the new specimens. The results of the first series of tests were published.

3. Wood and bamboo pulp.—The Economist visited some of the best bamboo areas of Burma where he made measurements and countings and collected much information regarding the possibility of establishing pulp mills. This has been recorded in a memoir now in the press, which will be completed when the result of certain tests with bamboo now being carried out by a Calcutta firm are made known. Bamboos and woods were supplied to the Chemist working at Dehra Dun.

4. The match industry.—The Economist visited several districts in Oudh, and after making countings, reported on the available quantity of *Simal* (*Bombax malabaricum*) and other woods and the facilities for extraction to a central site to be selected for a match factory. The conditions appear most favourable and it is hoped that a large factory will soon be started. Figures have also been obtained for several other localities which look promising. Woods were supplied to firms for testing for match making and it is evident that India is rich in such species.

5. Antiseptic treatment of woods.—Numerous experiments with different antiseptics have been continued as detailed in last year's report, but the most important work has been the powellizing by Messrs. Killick, Nixon & Co., at Bombay, of sleepers of the following species, which would not last as sleepers in their natural state:—

650 *Terminalia tomentosa* from Bombay.
431 *Dipterocarpus tuberculatus* from Burma.
127 *Dipterocarpus alatus* from Burma.

Six hundred and thirty-six of these have been treated and delivered to the Oudh and Rohilkhand Railway and the North Western Railway for use in the line, where their behaviour will be carefully noted. The remainder have been powellized, with the exception of a few unserviceable sleepers, and will be despatched during July to the Eastern Bengal State Railway for use in that Railway. About 1,900 pine sleepers from the Chakrata Division are also on their way to Bombay and a further supply of *Terminalia tomentosa* sleepers from Bombay and *Dipterocarpus* sleepers from Burma is also expected, the total number to be treated and issued to Railways being nearly 5,000.

Another experiment has been started with 2,000 sleepers of the same species which are to be treated with an antiseptic called *Avenarius Carbolineum* by the open-tank method. Eight hundred will be treated and laid down in Burma, 400 in Bombay, and 800 in Northern India.

The object of these experiments is to endeavour to prove that native grown woods can be made suitable for sleepers at a cheap rate.

6. **Gums and resins.**—A large number of samples of gums and resins have been sent to various firms in India and Europe and numerous enquiries replied to, but the difficulty of supplying reliable estimates of cost, when small quantities only are handled, and of getting good samples of essences, etc., distilled in the forest and of sending perishable samples, have prevented much progress being made. Analyses of several gums and oils have been received and more are under enquiry. The most promising is Burmese wood-oil from *Melanorrhœa usitata* which has attracted a good deal of attention in Europe, as a result of the Forest Chemist's note on it.

7. **Tea boxes.**—The question of the best method of supplying cheap good tea boxes made of Indian woods to tea gardens, instead of the imported boxes which are at present imported in enormous quantities from Europe and Japan, is under consideration. It appears to be difficult to get any one to move in this matter, as the present arrangements are sanctioned by custom and vested interests, but it is hoped that the antiseptic treatment of certain of the more perishable or unsuitable woods, and increased facility of extraction, as well as possibly the utilization of bamboo-pulp, may help to solve the difficulty in time.

8. **Miscellaneous uses of woods.**—Samples have been supplied to, and experimented with by, makers of matches, pencils, brush-backs, razor handles, cricket bats, tool handles, weaving looms, and other minor goods.

9. **Collection of information on little known valuable woods.**—The information has now been nearly all collected for six timbers and is being written up.

10. **Minor investigations.**—Barks of *Terminalias* and Oaks have been collected green and analysed for tanning value, and myrobalans were collected at different seasons and tested for the same property. The rosin and turpentine industry in the Himalayas has been under enquiry, and help was given to purchasers to encourage the use of walnut burrs and Andamans padauk among other products. Besides the analyses mentioned above, roots of *Podophyllum Emodi* and leaves and bark of *Cinnamomum glanduliferum* were collected and sent to the Forest Chemist for analysis.

List of Publications.

Those marked by an asterisk are still in the press.

GROOM, PERCY .	. A Note on Pyinkado Timber. (*Ind. For., March-April 1911, 173.*)
HANKIN, E. H.	. Production of Synthetic Rubber. (*Ind. For., August 1910, 489.*)
PEARSON, R. S. .	. Note on the Relative Strength of Natural and Plantation Grown Teak in Burma. (*Forest Bulletin No. 3.*)
PEARSON, R. S. .	. Catalogue of the Economic Museum of the Forest Research Institute and College, Dehra Dun.
PEARSON, R. S. .	. *Commercial Guide to Indian Forest Products.
PEARSON, R. S. .	. *Note on Antiseptic Treatment of Timbers.
PEARSON, R. S. .	. *Note on the Paper-pulp Industry in India and Burma.
RAITT, W. .	. Paper and Paper-pulp Industry in India. (*Ind. For., January-February 1911, 1.*)
RAITT, W. .	. Paper-pulp testing at the Forestry Court, Cellulose Laboratory, United Provinces Exhibition, Allahabad. (*Ind. For., January, February, March, April, May 1911.*)

INDIAN ZOOLOGY

with special reference to the work done in the Indian Museum, October 1910 to September 1911, inclusive.

BY

N. ANNANDALE, B.A., D.Sc., C.M.Z.S., F.A.S.B.,

Superintendent of the Indian Museum.

As some misunderstanding has arisen about the scope of the report submitted annually to the Board of Scientific Advice by the Superintendent of the Indian Museum, I may be permitted to commence the present issue with a word of explanation. This report deals in the first instance with the zoological research published or in progress in the Indian Museum; it also deals, but in a less detailed manner, with other zoological research that has a direct bearing on the fauna of the Indian Empire, except that it ignores entomological and parasitological work carried out by Government departments whose representatives themselves submit reports to the Board and by similar departments in Native States. It is for this reason that the entomological investigations undertaken at Pusa, Dehra Dun and Bangalore are apparently neglected, and that no mention is made of the parasitological work of the Civil Veterinary Department.

I.—Work in the Indian Museum.

(*a*) *Laboratory Work.*

Captain F. H. Stewart, I.M.S., Honorary Assistant in the Indian Museum and formerly Surgeon-Naturalist to the Indian Marine Survey, has published a paper in our "Memoirs" on minute structure and post-larval development in certain genera of barnacles. The biological importance of this paper is considerable and the researches it embodies have a peculiar interest as regards zoological research in Calcutta, in that they are based on histological work of a delicate nature which was carried out entirely in our laboratories. It has often been denied that such work can be carried out in a tropical climate.

Dr. Annandale has completed a description of the freshwater Sponges, Hydrida and Polyzoa to form a volume in the "Fauna of British India" published under the authority of the Secretary of State in Council. This is the first volume in the series to be written entirely in India, and

it is one of two for the preparation of which in Calcutta sanction has been received, the other being Mr. Brunetti's account of the Nemocera other than Culicidæ, Chironomidæ and Cecidomyidæ. In the volume on the Sponges, etc., special stress has been laid on biological problems.

Mr. S. W. Kemp, besides publishing two short papers on Decapod Crustacea, has been engaged for the greater part of the year on a monograph of the Stomatopoda of the Indo-Pacific seas, and has recently prepared for our "Records" a series of preliminary descriptions of hitherto unrecognized forms. He has been much assisted by the loan of specimens from the British, the Colombo and the Sarawak Museums, and the collections of the Commissioner of Fisheries in New South Wales and of Professor Kishinouye of Tokyo. Mr. Kemp has also spent a considerable amount of time and trouble in improving our collection of the freshwater prawns of the Indian Empire with a view to the preparation next year of an account of the Indian species. Mr. Kemp's work on the higher Crustacea has a special interest for the Indian Museum in that it is in direct continuation of the investigations commenced in 1871 by the late Mr. J. Wood-Mason, then Deputy Superintendent. Mr. Wood-Mason's work on this group was carried on by Colonel Alcock, his successor as Superintendent, with such success that his monographs on the Decapoda have already become classics in taxonomic literature, and it is eminently satisfactory that the tradition thus created should be maintained.

Mr. B. L. Chaudhuri has worked on the large collection of freshwater fishes from Northern India obtained by Mr. M. Mackenzie and from other sources. He has also conducted experiments as regards the destruction of mosquito larvæ by various species of fish.

In the Entomological Sub-Section Mr. F. H. Gravely has commenced and nearly completed an account of the taxonomy, habits and distribution of the Oriental Pedipalpi. He has also done a considerable amount of work on the Scolopendridæ in the collection, and has supervised the preparation of some valuable original drawings of the mouth-parts of various blood-sucking flies. In collaboration with Mr. S. Maulik he has written an account of certain tree-haunting Neuropterous larvæ of the families Myrmeleonidæ and Ascalaphidæ. More recently Mr. Gravely has commenced the study of the beetles of the families Lucanidæ and Passalidæ that occur in India and the neighbouring countries. The former are forest pests of great importance, while the closely allied Passalidæ are of considerable scientific interest and can be studied in Calcutta with peculiar facility owing to our possession of the valuable collection of the late Dr. F. Stoliczka, one of the earliest students of the family. Mr. Gravely's work on the two families has been further

facilitated by the loan of specimens from the Bombay Natural History Society, the Museums of Madras, Trivandrum, Colombo and Sarawak and the Research Institutes at Pusa and Dehra Dun and the Government Entomologist, Ceylon.

In the same sub-section Mr. C. A. Paiva has collected data for a "census" of the mosquitoes of one district of Calcutta, and has devoted special attention to the habits of the predaceous larva of a species of *Toxorhynchites* which feeds on the larvæ of other mosquitoes, notably of the yellow fever mosquito *Stegomyia fasciata*.

A great part of Mr. Brunetti's time has been occupied in work on the Tipulidæ and other Nemocera for his volume in the "Fauna of British India." This work is now approaching completion. Mr. Brunetti has also published a revision of the Oriental blood-sucking Diptera of the family Muscidæ, and preliminary descriptions of about fifty new Indian species of the families Psychodidæ, Bibionidæ, Simuliidæ, Rhyphidæ, Dixidæ and Blepharoceridæ. He has now in the press a preliminary revision of the Oriental Tipulidæ and a revision of his catalogue of the Oriental Culicidæ published some years ago.

The Surgeon-Naturalist of the Indian Marine Survey, Captain R. B. Seymour Sewell, I.M.S., has worked in the Indian Museum during the monsoon. His main study has been that of the surface-living Copepoda of certain parts of the Burmese coast. He has devoted special attention to the biological and hydrographical factors in the distribution of these little Crustacea as well as to their taxonomy. Captain Sewell has also prepared in the Museum a detailed report on the deep-sea fish taken last season by the R. I. M. S. "Investigator" and, in collaboration with Mr. Kemp, has worked out the deep-sea Decapod Crustacea.

(*b*) *Field Work.*

Dr. Annandale spent ten days at Bangalore during the Puja holidays in October 1910, and obtained, with the assistance of Dr. Morris Travers, F.R.S., a representative collection of the Crustacea and Sponges of the district as well as a number of insects. Specimens from the State of Mysore were much needed in the Museum. Accompanied by Mr. Gravely, Dr. Annandale also visited Puri on the Orissa coast in January. The ostensible object of this trip was to collect marine organisms, but unfavourable meteorological conditions rendered this difficult and special attention was paid to the Crustacea and leeches of ponds and streams and of the Sur Lake, which is situated about four miles from Puri. A good series of freshwater prawns (especially of the family Atyidæ) and leeches

of the family Glossosiphonidæ was obtained. A second visit was paid to the Sur Lake by Dr. Annandale and Mr. Gravely in September and an interesting collection of the fauna of the sand-dunes which separate the lake from the sea was obtained.

Mr. S. W. Kemp in May 1911 visited the lakes of Kumaon in the W. Himalayas and obtained a very interesting collection of the invertebrate fauna, especially of the Crustacea, Polyzoa and Sponges. The invertebrates of these lakes were hitherto almost unknown.

The field work undertaken of recent years by the Indian Museum has been for the most part of a somewhat indiscriminate nature. This was unavoidable so long as only one officer could go on tour, but now that the scientific staff has been increased to four officers, we are in a position to specialize further and our field work is being pressed on mainly in two directions, namely:—

(i) A survey of the freshwater fauna of the Indian Empire.

(ii) The collection and observation of those groups of insects and arachnida which are actually being worked out in the Museum and of those regarding which arrangements for identification have been made with specialists abroad.

The survey of the freshwater fauna of the Indian Empire was really commenced about 40 years ago by the late Mr. J. Wood-Mason, but the importance of the investigations on marine zoology undertaken in succeeding years totally overshadowed it. It is now our endeavour, without neglecting marine zoology, to press on the survey of the rivers and lakes of India and Burma. The first-fruits of this survey are to be found in Colonel Alcock's revision of the freshwater crabs published in the Catalogue of Decapod Crustacea of the Indian Museum last year. Other published results are Dr. Annandale's account of the freshwater Sponges, Hydroids and Polyzoa in the "Fauna of British India" and Mr. Kemp's account of the Crustacea Anostraca in a recent number of the "Records of the Indian Museum," while work in progress in the Museum includes an account of the freshwater fishes of Northern India by Mr. Chaudhuri and of several families of flies which pass their earlier stages in water by Mr. E. Brunetti. The account of the aquatic Rhynchota in vol. v of Mr. W. L. Distant's account of this order of insects in the "Fauna of British India" is largely based on specimens sent from the Indian Museum, and the same will be the case with future volumes in the same series on the leeches by Mr. W. A. Harding and on the molluscs of the family Unionidæ by Mr. H. B. Preston. Collections of freshwater microscopic Crustacea and other

plancton from over two hundred localities have also been sent to be worked out by Professor E. von Daday of Buda-Pesth, while Major J. Stephenson, I.M.S., Professor of Biology in the Government College, Lahore, is publishing a series of papers on the aquatic oligochaete worms collected by us. It may therefore be stated with confidence that our survey of the freshwater fauna has already made and is continuing to make great progress. We have to thank a large number of private persons in different parts of India and Burma for assistance in the survey.

The collection and observation of insects and Arachnida belonging to special groups is at once a more simple and a more difficult matter than the conduct of a survey of the freshwater fauna. Specimens are as a rule more easily obtained, but in most cases it is difficult, if not impossible, to assign them to their proper groups in the field. Our special attention has been directed to the Arachnid group Pedipalpi, on which Mr. Gravely is preparing an elaborate monograph, but efforts have also been made to obtain specimens of the families of Diptera to which Mr. Brunetti has recently devoted his attention, and we have also endeavoured to gather together as many specimens as possible of those groups of insects on which volumes are being written in the "Fauna of British India." As regards insects and Arachnida we have also to thank a large number of private collectors for specimens.

Although the marine field work undertaken by the Surgeon-Naturalist to the Indian Marine Survey is not, strictly speaking, a part of the work of the Museum, it may be discussed here because all the specimens he obtains become the property of the Museum. The biological investigations of the R. I. M. S. "Investigator" have attained a world-wide celebrity, thanks to the energy and scientific knowledge of succeeding Surgeon-Naturalists, and it is therefore unfortunate that the exigencies of survey work have recently somewhat lessened the opportunities given to the Surgeon-Naturalist. The following table showing the number of trawls made in different seasons illustrates this fact with sufficient clearness:—

Survey seasons.	Average number of trawls.
1887-88 to 1891-92	30·8
1892-93 to 1896-97	17·8
1897-98 to 1901-02	15·6
1902-03 to 1906-07	14·6
1907-08 to 1910-11	3·75

Another fact, however, is not always appreciated, *viz.*, that we now know a good deal more of the deep-sea or abyssal fauna of Indian seas than we do of the littoral and sub-littoral fauna, and that the mid-water fauna of these seas has hitherto been totally neglected. If this fact were appreciated it might perhaps be possible for greater facilities to be granted to the Surgeon-Naturalist, even if it is no longer possible to trawl in deep water so frequently as was once the case. Last season Captain Sewell did a good deal of valuable work in shore, collecting on the coast of Tavoy and on the Moscos Islands, as well as in collecting and studying the surface plancton (botanical as well as zoological) off the same coast.

II.—Work done in India outside the Museum.

Great activity has recently been displayed, especially in the Punjab, by officers of the Indian Medical Service as regards the identification and description of mosquitoes, the most important result, so far as publications go, being the issue of a new edition of James and Liston's "Anopheline Mosquitoes of India." This handsome volume is practically a new work, the whole having been completely revised and much new material added. It is unfortunate that the authors have greatly discounted its value from a zoological point of view by totally ignoring the rules of nomenclature accepted by zoologists, and it is to be feared that the great confusion which already exists as regards some of the commonest Indian mosquitoes will be thereby still further increased. This is the more unfortunate as the book contains much information of great value. Major S. R. Christophers and Major S. P. James, of the Indian Medical Service, have also published several papers on mosquitoes in "Paludism," the new journal devoted to the study of malaria and published officially by the sanitary authorities.

One of the most important zoological discoveries recently made in India is that of a freshwater medusa of the genus *Limnocnida* in tributaries of the river Krishna. This discovery is due to Mr. S. P. Agharkar, Lecturer on Biology in the Elphinstone College, Bombay, who, after studying for some time in the laboratories of the Indian Museum in Calcutta, made important collections of the lower aquatic invertebrates in the streams of the Western Ghats and presented them to us. *Limnocnida* was at one time thought to be peculiar to Lake Tanganyika in Central Africa, its existence in which was one of the strongest arguments brought forward in support of the now discredited theory that Lake Tanganyika had recently been connected with the sea. The medusa,

however, has now been found in other African lakes and also in a lagoon at the mouth of the river Niger near the West Coast of Africa. Its existence in India was not hitherto suspected, although Lieutenant-Colonel A. Alcock, F.R.S., obtained a single specimen of a freshwater medusa in Chota Nagpur many years ago.

The Bombay Natural History Society has during the past year inaugurated an important movement by collecting subscriptions for a survey of the mammals of India, the smaller members of this group being still practically unknown. The movement has been successfully inaugurated by the appointment of a trained collector, who is now at work in Western India; and Mr. Oldfield Thomas, F.R.S., of the British Museum has undertaken to arrange for the identification and description of the species. It is to be hoped that the results will finally be dealt with in a connected form and will not consist merely of a series of papers in which new species and sub-species are described.

In the Government College, Lahore, Major J. Stephenson, I.M.S., has continued his studies on aquatic oligochæte worms, the results of which are published from time to time in the "Records of the Indian Museum." In the "Journal of the Bombay Natural History Society" a number of papers, chiefly on birds and other popular groups, have been published; special mention may be made of Major F. Wall's papers on snakes, and regret may be expressed as to the number of "new species" he has found it necessary to describe.

III.—Work done in Europe and America.

In the official "Fauna of British India" a fifth volume on the Rhynchota has been published by Mr. W. L. Distant, containing descriptions of species belonging to eighteen families of Heteroptera and added to the Indian fauna since the publication of the earlier volumes on the order. Letters in an interesting correspondence regarding the "Fauna" are published in an appendix to the report of the officer in charge of the Zoological Section of the Indian Museum for the financial year 1910-11. There is always danger of a "Fauna," written in a country other than that to which the animals belong, developing into a dry museum compilation in which only old and faded specimens are described, of little use except to specialists in the groups discussed; the fact that even dried specimens were once living animals is apt to be forgotten, and geographical facts are ignored or distorted. The "Fauna of British India" has recently been criticised

severely from this point of view by "H. M. L." in Journ. Bombay Nat. Hist. Soc., vol. xx, p. 841; but it cannot be denied that a great improvement has been made in the volumes issued under the present Editor, who has shown himself sympathetic to work done in India, and it is perhaps not too much to hope that as the study of zoology progresses in this country and the number of zoologists increases, more and more of the volumes of the "Fauna" will be written by men with an intimate personal knowledge of the country and qualified by the examination in a living condition and even in their natural surroundings of at least some of the animals which they discuss, as well as of the whole of the collections preserved in India, to speak with some authority on the natural appearance of these animals and to discuss their biology and distribution.

A very important addition to our knowledge of the fauna of Indian seas will be published shortly in Mr. A. H. Clark's (of Washington, U. S. A.) account of the Crinoids in the collection of the Indian Museum. This work will form a part of the "Catalogue of the Echinoderms of the Indian Museum," but will differ from the parts already issued in including a synonymic catalogue of all the species as yet recorded from the Indo-Pacific region as well as much information of theoretical interest and a complete bibliography. In order to complete his catalogue Mr. Clark has examined practically all the material preserved in European and American museums as well as that sent him from Calcutta.

Other work on the Indian fauna recently carried out in Europe and America is noticed in the attached bibliography, which has been compiled by Mr. B. L. Chaudhuri, Assistant Superintendent, Indian Museum. Special attention may be directed to the investigations on the anatomy of Indian snails carried out by the veteran Indian naturalist, Lieutenant-Colonel H. H. Godwin-Austen, F.R.S., and also to Dr. W. Michaelsen's studies of the taxonomy and distribution of Indian earthworms (Abh. Naturwiss. Ver. Hamburg, xix, 1910).

List of papers, memoirs and books having a special reference to Indian Zoology recently published.

Memoirs published in India.

GENERAL.

In the *Records of the Indian Museum*. Report on a collection of aquatic animals made in Tibet by Captain F. H. Stewart, I.M.S.,

during the year 1907. Part III—Turbellaria and Summary. By Dr. A. Meixner, A. Muth and Captain F. H. Stewart, M.A., D.Sc., M.B., I.M.S. Vol. vi, 57.

In the *Journal and Proceedings of the Asiatic Society of Bengal.* Materia Medica Animalium Indica. By David Hooper, F.C.S. Vol. vi, 1910, 507.

In the *Journal of the Bombay Natural History Society.* Notes on Game Animals from near Gyantse and in the Chumbi Valley. By Captain F. H. Bailey. Vol. xx, Part 4, 1028.

In the *Agricultural Ledger.* Bat and Bird Guano in India. By I. H. Burkill, M.A. Nos. 1 and 2 of 1911.

Protozoa.

In the *Spolia Zeylanica.* On some Parasitic Protozoa from Ceylon. By Clifford Dobell, M.A. Vol. vii, 1910, 65.

Porifera (Sponges).

In the *Records of the Indian Museum.* Some Sponges associated with gregarious Molluscs of the family Vermetidæ. By Dr. N. Annandale, D.Sc., F.L.S., C.M.Z.S., Superintendent, Indian Museum. Vol. vi, 1911, 47.

Notes on the Sponges. By the same author. Vol. vi, 1911, 225.

In the *Spolia Zeylanica.* Notes on a freshwater Sponge from Ceylon. By the same author. Vol. vii, 1910, 63.

Vermes.

In the *Records of the Indian Museum.* On some aquatic Oligochæte worms commensal in *Spongilla carteri.* By Major J. Stephenson, M.B., D.Sc. Vol. v, 1910, 233.

On *Bothrioneurum iris*, Beddard. By the same author. Vol. v, 1910, 241.

On some aquatic Oligochæta in the collection of the Indian Museum. By the same author. Vol. vi, 1911, 203.

In the *Spolia Zeylanica.* Notes on new land Planarian from Ceylon. By Dr. Iwaji Ikeda. Vol. vii, 1911, 113.

Some notes on the Ceylon Pearl-inducing worm. By T. Southwell, A.R.C.Sc., F.L.S., F.Z.S. Vol. vii, 1911, 124.

Some remarks on the occurrence of Cestodes in Ceylon. By the same author. Vol. vii, 1911, 194.

In the *Ceylon Marine Biological Reports*. Description of nine new species of Cestode Parasites, including two new genera from Marine Fishes of Ceylon. By the same author. Part v, 1911, 216.

Crustacea.

In the *Memoirs of the Indian Museum*. Studies in post-larval development and minute anatomy in the genera *Scalpellum* and *Ibla*. By Captain F. H. Stewart, M.A., D.Sc., M.B., I.M.S. Vol. iii, No. 2, 1911.

In the *Records of the Indian Museum*. On the classification of the Potamonidæ (Telphusidæ). By Colonel A. Alcock, C.I.E., F.R.S. Vol. v, 1910, 253.

On certain species of *Palæmon* from South India. By J. R. Henderson, M.B., F.L.S., and George Mathai, M.A. *Ibid.*, 277.

Note on a Rhizocephalous crustacean from fresh water and on some specimens of the order from Indian seas. By Dr. N. Annandale, D.Sc., Superintendent, Indian Museum. Vol. vi, 1911, 1.

Notes on Decapoda in the Indian Museum (II). By S. W. Kemp, B.A., Assistant Superintendent, Indian Museum. *Ibid.*, 5.

Preliminary description of new species and varieties of Crustacea Stomatopoda in the Indian Museum. By the same author. Vol. vi, 1911, 93.

Indian Isopods. By the Rev. Thomas R. R. Stebbing, M.A., F.R.S. Vol. vi, 1911, 179.

Notes on Asiatic species of Crustacea Anostraca in the Indian Museum. By S. W. Kemp, B.A. *Ibid.*, 229.

In the *Journal of the Bombay Natural History Society*. Notes on the growth of Barnacles in Indian seas. By N. Annandale, D.Sc. Vol. xx, 1911, 1170.

In the *Spolia Zeylanica*. Association of Barnacles with Snakes and Worms. By Dr. A. Willey, D.Sc., F.R.S. Vol. vi, 1910, 180.

Myriapoda.

In the *Spolia Zeylanica*. Symphyla of Ceylon. By F. H. Gravely, M.Sc., Assistant Superintendent, Indian Museum. Vol. vii, 1910, 110.

INSECTS.

In the *Records of the Indian Museum*. A revision of the species of *Tabanus* from the Oriental region including notes on species from surrounding countries. By Gertrude Ricardo. Vol. iv, No. vi, 1911, 111.

Notes and descriptions of the Indian Microlepidoptera. By E. Meyrick, B.A., F.R.S. Vol. v, 1910, 217.

Allonadella himalayensis, a new species of degenerate male Cockroach. By F. H. Gravely, M.Sc., Assistant Superintendent, Indian Museum. *Ibid.*, 307.

Rhynchota Malayana. Part III. By W. L. Distant. *Ibid.*, 313.

Contributions to the Fauna of Yunnan. III.—Butterflies. By G. W. V. deRhé-Philipe, F.Z.S. Vol. vi, 1911, 25.

Contributions to the Fauna of Yunnan. IV.—Les Chironomides (Tendipedidæ). Par J. J. Kieffer, Doct. Phil. Nat., Professeur à Bitesch. *Ibid.*, 27.

Contributions to the Fauna of Yunnan. V.—Bibionidæ, Mycetophilidæ and Anophelinæ. By E. Brunetti and Major S. P. James, I.M.S. *Ibid.*, 31.

Report on a small collection of fleas from India and China. By the Hon. N. Charles Rothschild. *Ibid.*, 43.

New Oriental Nemocera. By E. Brunetti. Vol. iv, No. vii, 1911, 259.

Synonymy in Corethrinæ. By the same author. *Ibid.*, 317.

Further notes on Indian *Phlebotomi*. By Dr. N. Annandale, D.Sc., Superintendent, Indian Museum. *Ibid.*, 320.

Notes on the development of some Indian Ascalaphidæ and Myrmeleonidæ. By F. H. Gravely, M.Sc., Assistant Superintendent, Indian Museum, and S. Maulik. Vol. vi, 1911, 101.

The occurrence of *Dactylopius citri*, Risso, in the Himalayas. By Professor A. D. Imms. *Ibid.*, 111.

Notes on aquatic Rhynchota. By Dr. N. Annandale, D.Sc., Superintendent, Indian Museum. *Ibid.*, 112.

Description de nouveaux Chironomides de l'Indian Museum de Calcutta. Par J. J. Kieffer, Doct. Phil. Nat., Prof. à Bitesch. Vol. vi, 1911, 113.

Further notes on synonymy in Corethrinæ. By E. Brunetti. Vol. vi, 1911, 227.

In the *Journal of the Bombay Natural History Society*. The Moths of India. Series iv, Parts 1 and 2. By Sir George F. Hampson, Bart., F.Z.S., F.E.S. Vol. xx, 1911, 634 and 1046.

Description of Indian Microlepidoptera. By E. Meyrick, B.A., F.R.S., F.Z.S. *Ibid.*, 706.

Notes on some Butterflies from the Indian Region. By G. W. V. de Rhé-Philipe, F.E.S. *Ibid.*, 753.

Common Butterflies of the plains of India. Part ix. By T. R. Bell. *Ibid.*, 1115.

Notes on the Bug, *Aspongopus janus*. By Dr. Harold H. Mann, D.Sc., Principal, Poona Agricultural College. *Ibid.*, 1166.

In the *Indian Forest Memoirs*. On some important Pests of the Coniferæ of the Himalaya with notes on some Insects predaceous and parasitic upon them. By E. P. Stebbing, F.Z.S., F.R.G.S. Vol. ii, Part i, 1911.

In the Forest Bulletin. The blue pine *Tomicus* Bark-Borer. By the same author. No. 5, 1911.

In the *Paludism*. Aids to the identification of Culicidæ other than Anopheles with special reference to Indian species. By Major S. R. Christophers, I.M.S. No. 3, 1911, 40.

In the *Indian Medical Gazette*. An Anopheline allied to *Myzomyia listoni*. By U. N. Bramhachari, M.A., M.D., Ph.D. Vol. xlvi, 1911, 268.

In the *Spolia Zeylanica*. Sand Flies (*Phlebotomus*) from Peradeniya. By Dr. N. Annandale, D.Sc., Superintendent, Indian Museum. Vol. vii, 1910, 57.

Life of the Leaf Insect (*Pulchriphyllium crurifolium*). By E. E. Green. *Ibid.*, 106.

Note on a Passenger-carrying Beetle (*Scarabæus gangeticus*). By the same author. *Ibid.*, 107.

Notes on Ceylonese Tetriginæ with descriptions of some new species. By Dr. Joseph Lane Hancock, M.D., F.E.S. Vol. vi, 1910, 140.

The Plume Moths of Ceylon. Part ii. The Orneodidæ. By T. Bainbrigge Fletcher, R.N., F.E.S., F.Z.S. *Ibid.*, 156.

Note on Ceylon Diptera. By E. Brunetti. *Ibid.*, 170.

New Hymenoptera from Ceylon. By Rowland E. Turner, F.Z.S. Vol. vii, 1911, 141.

A new Mason Wasp. By Geoffrey Meade-Waldo, B.A. *Ibid.*, 155.

Arachnoidea.

In the *Records of the Indian Museum*. Notes on Pedipalpi in the collection of the Indian Museum. By F. H. Gravely, M.Sc., Assistant Superintendent, Indian Museum. Vol. vi, 1911, 33.

In the *Spolia Zeylanica*. The species of Ceylon Pedipalpi. By the same author. Vol. vii, 1911, 135.

Mollusca.

In the *Records of the Indian Museum*. Notes on Nudibranchs from the Indian Museum. By Sir Charles Eliot, K.C.M.G., F.Z.S., Vice-Chancellor of the University of Sheffield. Vol. v, 1910, 247.

Descriptions of six new species of shells from Bengal and Madras. By H. B. Preston, F.Z.S. Vol. vi, 1911, 39.

In the *Madras Fisheries Bureau* series. The practice of Oyster culture at Arcachon and its lessons for India. By James Hornell, F.L.S. Vol. ii, Bulletin No. 5.

Polyzoa.

In the *Records of the Indian Museum*. Systematic notes on the Ctenostomatous Polyzoa of fresh water. By Dr. N. Annandale, D.Sc., Superintendent, Indian Museum. Vol. vi, 1911, 103.

In the *Spolia Zeylanica*. Note on a freshwater Polyzoon from Ceylon. By the same author. Vol. vii, 1910, 63.

Fishes.

In the *Memoirs of the Indian Museum*. Report on the Fishes taken by the Bengal Fisheries Steamer "Golden Crown." Part ii. Additional notes on the Batoidei. By Dr. N. Annandale, D.Sc., Superintendent, Indian Museum. Part iii. Plectognathi and Pediculati. By Drs. N. Annandale and J. T. Jenkins. Part iv. Pleuronectidæ. By Dr. J. T. Jenkins, D.Sc., Ph.D. Vol. iii, No. 1, 1910.

In the *Records of the Indian Museum*. Contributions to the Fauna of Yunnan, Part ii. Fishes. By B. L. Chaudhuri, B.A., B.Sc., Assistant Superintendent, Indian Museum. Vol. vi, 1911, 13.

Notes on Cyprinidæ from Tibet and the Chumbi Valley, with a description of a new species of *Gymnocypris*. By Captain F. H. Stewart, I.M.S. *Ibid.*, 73.

In the *Spolia Zeylanica*. A descriptive note on the capture of a large Saw-Fish containing intra-uterine embryos. By T. Southwell, A.R.C.Sc., F.L.S. Vol. vi, 1910, 137.

Notes on the freshwater Fisheries of Ceylon. By Dr. A. Willey, M.A., D.Sc., F.R.S. Vol. vii, 1910, 88.

Amphibians.

In the *Records of the Indian Museum*. Contributions to the Fauna of Yunnan. Part vi. Batrachia. By Dr. N. Annandale, D.Sc., Superintendent, Indian Museum. Vol. vi, 1911, 215.

In the *Agricultural Ledger*. Edible Frogs in India. By I. H Burkill, M.A. No. 2, 1911, 11.

Reptiles.

In the *Records of the Indian Museum*. Contributions to the Fauna of Yunnan. Part vi. Reptiles. By Dr. N. Annandale, D.Sc., Superintendent, Indian Museum. Vol. vi, 1911, 215.

In the *Journal of the Bombay Natural History Society*. A popular treatise on the common Indian Snakes. Parts xiv and xv. By Major F. Wall, I.M.S. Vol. xx, 1911, 597 and 933.

Further notes on Snakes from the Chin Hills. By Captain F. E. W. Venning. *Ibid.*, 770.

Birds.

In the *Records of the Indian Museum*. Catalogue of the Pheasants, Peafowl, Jungle Fowl and Spur Fowl in the Indian Museum. By C. W. Beebe. Vol. v, 1910, 263.

In the *Journal of the Bombay Natural History Society*. The Game Birds of India, Burma and Ceylon. Parts iii and iv. By E. C. Stuart Baker, F.L.S., F.Z.S. Vol. xx, 1911, 547 and 901.

On the Birds of Kohat and Kuram Valley. Parts ii and iii. By Lieutenant C. H. T. Whitehead. *Ibid.*, 776 and 954.

Some Maymyo Birds. By Major H. A. Harrington. *Ibid.*, 1002.

Mammals.

In the *Spolia Zeylanica*. Note on a Cannibal Bat. By E. E. Green. Vol. vii, 1910, 106.

In the *Journal of the Bombay Natural History Society*. The Kathiawar Lion. By Lieutenant-Colonel Fenton. Vol. xx, 1911, 737.

"The pale Weasel" of Blanford's "Mammalia" and a new Himalayan Vole. By. R. C. Wroughton. *Ibid.*, 930.

A new Murine genus and species from Sind. By Oldfield Thomas, F.R.S. *Ibid.*, 996.

A small collection of Rodents from Lower Sind. By R. C. Wroughton. *Ibid.*, 1000.

Oriental Flying Squirrels of the *Pteromys* group. By the same author. *Ibid.*, 1012.

Memoirs published in Europe, America, etc.

General.

Fauna of British India. Freshwater Sponges, Hydroids and Polyzoa. By Dr. N. Annandale, D.Sc., Superintendent, Indian Museum.

Vermes.

A contribution to our knowledge of the Oligochæta of Travancore. By Luige Cognette de Martiis. Ann. Mag. Nat. Hist., vol. vii (8th series), 1911, 494.

Crustacea.

Beiträge zur Kenntnis der Isopoden-fauna Ostasiens. Von Martin Thielemann. Beiträge zur Naturgeschichte Ostasiens. München, 1910.

Egy uj Cladocera faj Keletindiabol. Irta Dr. Daday. Jano. Allattani Koszlemenyek. Vol. x, 1911, 63.

Insects.

Die Palæarktischen Tortriciden. Von Dr. J. Kennel. Zoologica (Stuttgart), Heft 54, 1910, 127.

The influence of Temperature upon the biting of Mosquitoes. By F. M. Horslett, B.A., F.E.S. Parasitology, vol. iii, 1911, 479.

On the collection and preservation of Insects. By the same author. *Ibid.*, 485.

Description of new Syntomidæ. By the Hon'ble Walter Rothschild, Ph.D. Novitates Zoologicæ, vol. xvii, No. 3, 1910, 432.

New Saturniidæ. By Karl Jordon. *Ibid.*, 470.

Histeridæ (Coleopterorum Catalogus). Editus A. S. Schenkling. Pars 24, 1910.

Monographie des Buprestides. Von C. H. Kirremans. Tome v, 1910, Bruxelles.

Description of a new genus and three new species of Anopheline Mosquitoes. By R. Newstead, M.Sc., and H. J. Carter. Annals of Tropical Medicine and Parasitology, vol. iv, No. 3, 1910, 377.

Materiali per Lo Studio Dei Tisanuri. Nova Specie di Lepidospora di Ceylon. F. Silvestri. Estratto dal Bollettino del Laboratorio di Zoologia generale e agraria della R. Scuola superiore d'Agricultura in Porlici, vol. v, 1910.

Lepidoptera Indica. By Colonel Swinhoe, M.A., F.L.S., F.Z.S. Parts lxxxix—xciii, 1911.

Genera Insectorum. Fam. Ornеodidæ (India as centre of origin). By E. Meyrick. 108me Fascicule.

Indo-Australische Anthomyiden des Budapester Museum. Von Prof. P. Stein. Annales Historico-Naturales Musei Nationalis Hungarici, vol. iii, 1910, Pars seconda.

Rhynchota Indica (Heteroptera). By W. L. Distant. The Entomologist, January 1911, 22.

Fourmis de Borneo, Singapore, Ceylon, etc. Par A. Forel. Revue Suisse de Zoologie, vol. xix, No. 2, 1910.

Neue Hesperiden des Indo-Malayischen Faunengebietes und Besprechung verwandter Formen. Von H. Fruhstorfer. Iris, Dresden. Band xxv, Hefts 2 and 3, 1910 and 1911, 25.

Locusts in Australia and other countries. By Walter W. Froggatt. Farmer's Bulletin. Department of Agriculture, New South Wales. No. 29, 1910.

On the Life-History of Chermes himalayensis, Steb., on the Spruce and Silver Fir. By E. P. Stebbing, F.Z.S. The Transactions of the Linnean Society of London (second series), vol. xi, part 6, 1910, 99.

Termitofili a Ceylon. Par F. Silvestri. Porlici, Zoologische Jahrbucher, Heft 4, Band xxx, 1911, 401.

Fauna of British India. Coleoptera lamellicornia (Cetoniinæ and Dynastinæ). By G. J. Arrow.

Fauna of British India. Rhynchota. Vol. v. Heteroptera. Appendix. By W. L. Distant.

Termitenleben auf Ceylon, neue Studien zur Soziologie der Tiere zugleich ein kapital kolonialer Forst Entomologie. By Prof. K. Escherich. Jena, 1911.

The Sinmese Grain Beetle (Lophocateres pusillus, Klug.) reported from Ceylon. By F. H. Chittenden, Sc.D., U. S. Department of Agriculture. Bulletin No. 96, 1911, 14.

Notes on Fossorial Hymenoptera (with descriptions of new species from Ceylon). By Rowland E. Turner, F.Z.S. Ann. Mag. Nat. Hist., vol. vii (8th series), 1911, 479.

Descriptions and records of Bees (with descriptions of species from India). By T. D. A. Cockerell. *Ibid.*, 485.

On some Coccidæ affecting rubber trees in Ceylon, with descriptions of new species. By E. Ernest Green. The Journal of Economic Biology, vol. vi, 1911, 62.

On some Tipulidæ from Ceylon with description of 8 new species. By E. W. Edwards, B.A. Ann. Mag. Nat. Hist., vol. viii (8th series), 1911, 58.

On the Ruteline Coleoptera of Ceylon, with description of new species. By Gilbert J. Arrow. *Ibid.*, 364.

Arachnoidea.

On two collections of Indian Ticks. By Cecil Warburton, M.A., Zoologist to the Royal Agricultural Society. Parasitology, vol. iii, 1910, 395.

Notes on Acari (Indian species). By Dr. A. C. Oudemans. Tijdschrift voor Entomologie. 1910, 197.

Opiliones aus Britisch Indien und Sarwak. By Dr. C. F. Roewer. Archiv für Naturgeschichte. Band i, Heft 2, 1911, 160.

On a new Pedipalp from Burma. By S. Hirst. Ann. Mag. Nat. Hist., vol. viii (8th series), 1911, 380.

Molluscs.

The wandering of a gigantic African Snail in Ceylon. By E. Ernest Green. The Zoologist, 1911, 41.

Subfamilie Pterocycleæ. Conchylien Cabinet von Martini und Chemnitz. Nürnberg. Band i, Heft 235, 1911, 713.

Description of *Oxytes beddomei*. By Lieut.-Col. H. H. Godwin-Austen, F.R.S. Proc. Malacological Society. Vol. ix, Part v, 1911, 327.

Fishes.

A new case of parental care among fishes. By Prof. Max Weber. Reprint from the Proceedings of the Meeting of Akademie van Wetenschappen te Amsterdam, 1910, 583.

Notes on some Beaufort Fishes. By E. W. Gudger. The American Naturalist, vol. xliv, 1910, 395.

Birds.

Notes on the genus *Spelæornis*. By Dr. Ernst Hartert, Ph.D. The Novitates Zoologicæ, vol. xvii, No. 3, 1910, 481.

The correct name of the green Bee-eater. By the same author. *Ibid.*, 482.

Mammals.

On the specialised cutaneous Scent-Glands of Ruminants. By R. I. Pocock, F.L.S., F.Z.S., Superintendent of the Zoological Gardens, London. Proc. Zool. Society (London), Part iv, 1910, 840.

A Wapiti and a Muntjac. By R. Lydekker, F.R.S. *Ibid.*, 987.

Rats and Plague. By C. B. Kloss. Journal of the Straits Branch of the Royal Asiatic Society, No. 57, 1910, 157.

New Asiatic Muridæ. By Oldfield Thomas. Ann. Mag. Nat. Hist., vol. vii (8th series), 1911, 205.

ECONOMIC ENTOMOLOGY.

BY

T. BAINBRIGGE FLETCHER, R.N., F.E.S., F.Z.S.,

Officiating Imperial Entomologist.

I.—Agricultural Entomology.

(a) Pusa Research Institute.

The study of the life-histories and habits of injurious insects was continued at the Pusa Research Institute and by the Assistants in the Provincial Agricultural Departments. The more important of these insect pests have been the—

Rhinoceros Beetle (*Oryctes rhinoceros*).
Surface Grasshopper (*Chrotogonus trachypterus*).
Painted Grasshopper (*Pœcilocera picta*).
Tingid Potato Bug.
Lucerne Hypera (*Hypera medicaginis*).
Small Cabbage Caterpillar (*Hellula undalis*).
Rice Weevil (*Calandra oryzæ*).
Green Bug (*Nezara viridula*).
Potato Mealy Bug (*Dactylopius nipæ*).
Fish Insect (*Lepisma sp.*).
Red Pumpkin Beetle (*Aulacophora foveicollis*).
Termites (*Termes spp.*).

Work on methods of checking the mound-building White-ant (*Termes sp.*) has been continued in collaboration with the Deputy Director of Agriculture, Northern Circle, Central Provinces, and considerable success has been obtained though the experiments are not yet completed. Numerous insecticides sent in for trial have been tested and reported on. Three students have been given a training in advanced Entomology at Pusa, whilst thirteen and fifteen applicants from all parts of India have been given short courses of practical training in Sericulture and Lac-culture respectively.

Experiments have been made on the crossing of Italian and French univoltine Mulberry Silkworms with all the available indigenous multivoltine races, the object being to secure a robust and vigorous multivoltine race yielding a better quality of silk than is produced by the native

forms at present cultivated; the earlier stages of such a series of experiments are necessarily devoted largely to the elimination of useless forms, but the information obtained appears to justify the continuance of these attempts. Two broods of Mulberry silkworms from imported European seed were successfully reared at Pusa on bush mulberry between November and March and the resulting silk was reported on in extremely favourable terms. The cultivation of the Eri silkworm was continued at Pusa and a great stimulus was given to this industry by the exhibits shown by this section at the Allahabad Exhibition. Ericulture has been taken up by the Provincial Agricultural Departments of the United Provinces (at Shahjahanpur), of Bengal (at Sabour) and of Madras (at Coimbatore), and every effort has been made to bring rearers into touch with one another and with the silk trade for the supply and disposal of eggs, cocoons and thread. Practical demonstrations of methods of silk-culture, spinning, reeling, etc., were given at numerous Agricultural Exhibitions held in Bengal and Eastern Bengal and Assam. A simple machine, for the doubling and twisting of thread in one action was invented at the instance of this Department by Mr. Watson, of Muzaffarpur, and has been made available.

Experimental work in lac-culture was continued at Pusa, and two courses of practical training in this subject were given during the year. In collaboration with the Forest Department a continuation was made of the collection of the races of lac insects from various trees with a view to investigation of their affinities. An investigation into Apiculture has been commenced, two races of specially-selected Italian honey-bees having been imported to Pusa in November 1910 with a view to ascertaining their suitability to the conditions prevalent in the plains of India, and the experiment has so far proved a success.

The Allahabad Exhibition (November 1910 to February 1911) offered an opportunity for demonstration that was not neglected. Besides a large working exhibit of silk-culture, cases were exhibited showing common Indian birds and their insect food, insects destructive to crops of the United Provinces, and the connection of insects with disease. Steady progress has been made in the preparation and issue of coloured plates of injurious and beneficial insects and a large series of these is now available for demonstration purposes, besides series on silk and lac. These plates have been very largely circulated and used by Provincial Departments.

A very large and constantly increasing volume of correspondence on insects is received and dealt with as far as possible and it is inevitable

that this branch of the work must expand as the work of the Department becomes better known. The parcels of injurious insects sent in during the year numbered 166, and in the same period 2,384 inquiries came in from official and public sources and were replied to officially. Advice and help to inquirers has formed no small part of the work of the staff during the past year and for this reason and on account of the large amount of other work now on hand no time has been available for original research.

(b) Provincial departments.

The work of the Entomological Assistants in the Provinces has been mainly confined to demonstration of methods of control of crop-pests and teaching of Elementary Entomology to students of General Agriculture at the Colleges. In Madras steady progress has been made in obtaining a knowledge of the life-history, occurrence and means of control of the crop pests of the Province, in the Central Provinces work against Potato Moth has been continued, in the United Provinces methods of control of Cane Grasshopper and Potato Moth have been demonstrated, and in Bengal methods have also been adopted against Potato Moth and good results achieved.

(c) Other works.

In the South of India, Mr. R. D. Anstead, Planting Expert, has continued to stimulate an interest in insect pests amongst the planting community, and in Mysore Dr. L. C. Coleman has published two Entomological bulletins, one on the Rice Grasshopper (*Hieroglyphus banian*), the other on the Deccan Grasshopper (*Colemania sphenarioides*). Mr. C. B. Antram, Entomologist to the Indian Tea Association, has continued his work on insect pests of tea.

II.—Forest Entomology.

The subject of the insects beneficial and injurious to Sal (*Shorea robusta*) received special attention during the year under review. Observations made in the Siwalik Hills on the common wood-borer *Hoplocerambyx spinicornis* indicate that its life-cycle extends over a period of two years; this borer has also been reported as damaging *Hardwickia binata* and *Chloroxylon Swietenia* in addition to Sal, so that it possesses considerable importance as a pest. Sal fruit attacked by larvæ of the Eucosmid moth, *Pammene theristis*, Meyr MS., was collected locally and the moths bred out in July-August, thus indicating that this pest has two generations in the year, one feeding in the roots of the young

seedling, the other living in the fruit. The above are two of the more important pests of Sal, but in addition many other insects of less importance were dealt with, some 1,500 specimens having been collected and many notes recorded regarding their life-histories and habits.

Great progress has been made with the reference collection of insects during the year, a total number of 1,220 named species having been added; of these 917 were received from the Pusa Research Institute and 143 from the Indian Museum. The species have been properly arranged in systematic order and a card index catalogue has been commenced. Special attention has been paid to the formation of a good reference collection of preserved larvæ and pupæ with a view to ready identification of economically important species. In addition to the named collection, a large number of specimens has been sent to Europe for identification, 51 parcels having been despatched during the year.

Specimens of seed-lac sent by the Imperial Sylviculturist from *Butea frondosa* trees in the Siwalik Division were kept under observation during the year. From this lac the following species were bred out:—

(*a*) *Eublemma amabilis*,

(*b*) *Hypatima pulverea*,

(*c*) *Stagmatophora xpolochtha*,

(*d*) *Silvanopsis iyeri*,

(*e*) *Berginus maindroni*,

of which the last two are new to science. Particular attention was paid to the dates of emergence as if parasitic species are found to emerge after the swarming of the brood-lac, the collection of the brood-lac sticks immediately before the swarming affords a means of checking the injurious predaceous and destructive insects.

The following insects sent in by Forest Officers during the year under review appear to be noteworthy:—

(*a*) Aphids (*Pemphigus bursarius*, Kalt.) sent from Naini Tal as forming galls on *Populus ciliata*.

(*b*) *Arhopala atrax*, Hewits., reported as defoliating Sal in the Kheri Division of the United Provinces.

(*c*) *Cyrtotrachelus longimanus*, Fb., reported as damaging shoots of *Dendrocalamus strictus*, and *Caryoborus gonagra*, Fb., reported as damaging seeds of *Hardwickia binata*, both from Saugor, Central Provinces.

(*d*) Two beetles attacking *Ficus elastica* in the Tista Division, Bengal. These proved to be *Mecotagus tigrinus* and *Hectarthrum iyeri*, Grouv. MS., the latter being a hitherto undescribed species and probably parasitic on the former.

(*e*) Beetles and flies damaging Sundri trees in the Sunderbans Division, Bengal.

(*f*) Specimens of *Oleneamptus curvipes* which were reported as having attacked wood of *Anogeissus latifolia* in Madras and Indore, but it is not clear as to whether healthy living trees were attacked or not.

(*g*) Specimens of a scale insect, *Leucaspis salicis*, Green MS., damaging Willow trees in Baluchistan.

(*h*) Various insects bred from seeds of *Albizzia Lebbek*, *Cassia Fistula*, *Bauhinia malabarica*, and *Dalbergia lanceolaria* communicated by the Imperial Sylviculturist.

Specimens sent in by eleven officers of the Department during the year were duly identified.

The Museum collection has been rearranged during the year and several additions have been made, amongst which may be mentioned:—

(*a*) Models of sections of White-ant's nest and of Ant-lion's pit.
(*b*) Model of wasp's nest.
(*c*) Model showing damage done by Cheroot Weevil.
(*d*) Wall-plates illustrating life-cycle of the malarial parasite.
(*e*) Two stuffed pythons obtained locally.

Specimens have been contributed to the collection during the year by the British Museum, the Indian Museum, Mr. E. Ernest Green, Ceylon Government Entomologist, and others.

The work of opening separate Ledger Files for each named species in the collection received careful attention during the year, as the information had hitherto been scattered through a number of routine office files.

List of Publications.

ANTRAM, C. B. . . Looper Tea Caterpillar. (*Indian Tea Association Journal.*)

ANTRAM, C. B. . . Capsid Bugs on Bamboos. (*Indian Tea Association Journal.*)

Bainbrigge - Fletcher, T.	Two Insect Pests of United Provinces. (*Agric. Jour. of India, April 1911.*)
Bainbrigge - Fletcher, T.	(Four Reviews in *Agric. Jour. of India* and one in *Jour. of Bombay Nat. Hist. Society.*)
Coleman, L. C. .	. Jola on Deccan Grasshopper. (*Mysore Entomological Bulletin No. 2.*)
Coleman, L. C. .	. The Rice Grasshopper. (*Mysore Entml. Bull. No. 1.*)
Ghosh, C. C. .	. Commercial possibilities of Eri Silk. (*Indian Industrial Congress Report.*)
Ghosh, C. C. .	. Palm Beetles. (*Mem. Dept. of Agric. India, Entomological Series, ii, No. 10.*)
Ghosh, C. C. .	. Life-history of *Croce filipennis*. (*Jour. of Bombay Nat. Hist. Society.*)
Iyer, V. S .	. Further note on *Casuarina* Insect Pests of Madras.
Mason, C. W.	. The Food of Birds in India. (*Mem. of Dept. of Agric. in India, Entomological Series, iii.*)
Maxwell-Lefroy, H.	Insecticides. (*Bull. A. R. I., Pusa, No. 23.*)
Maxwell-Lefroy, H., & Ghosh, C. C.	Eri Silk. (*Mem. Dept. of Agric. in India, Entomological Series, iv, No. 1.*)
Nowrojee, D. .	. Life-histories of Aquatic Insects. (*Mem. Dept. of Agric. in India, Entomological Series, ii, No. 9.*)
Patel, C. U. .	. Entomological Demonstration in Baroda. (*Agric. Jour. India, Oct. 1910.*)
Ramachandra, Rao	. Hairy Caterpillars in South Arcot. (*Agric. Jour. India, July 1910.*)
Stebbing, E. P.	. Note on Preservation of Bamboos from Shot-borer Beetle. (*Forest Pamphlet No. 15, 2nd Edition.*)
Stebbing, E. P.	. Monograph on Lac Insect. (*Forest Mem., i, Pt. 3, 2nd Edition.*)
Stebbing, E. P.	. Some Insect Pests of Himalayan Coniferæ. [*Forest Mem., ii, Pt. 1 (Deodar).*]
Stebbing, E. P.	. Life-history of *Chermes himalayensis*. (*Trans. Linnean Soc., xi, Pt. 6.*)
Stebbing, E. P.	. Some Insect Pests of Himalayan Coniferæ. [*Forest Mem., ii, Pt. 2 (Chir Pine).*]
Stebbing, E. P.	. The Blue Pine *Tomicus*.

STEBBING, E. P. . Some Bark-eating and Root-boring beetles of Babul.

Eri Silk as a Cottage Industry. (*Pusa Pamphlet in English, Urdu, and Hindi.*)

Mulberry Silk in the United Provinces. (*Pusa Pamphlet in English, Urdu, and Hindi.*)

List of Injurious Indian Insects. (*Pusa Pamphlet for use of Entomological Assistants.*)

List of Insects in Pusa Collection.

VETERINARY SCIENCE.

BY

MAJOR J. D. E. HOLMES, M.A., D.Sc., M.R.C.V.S.,
Imperial Bacteriologist.

The following table shews the output and issue of the various products at the Imperial Bacteriological Laboratory at Muktesar:—

Name.	Quantity prepared.	Quantity issued.	Increase.
	Doses.	Doses.	Doses.
Anti-Rinderpest Serum	577,050	583,779	168,891
Anti-Anthrax Serum	6,415	6,715	—6,758
Hæmorrhagic Septicæmia Vaccine	50,350	50,350	42,050
Anti-Hæmorrhagic Septicæmia Serum	1,825	1,825	1,825
Charbon Symptomatique Vaccine	38,400	19,000	13,050
Charbon Symptomatique Serum	...	536	...
Mallein	12,041	16,220	3,426
Tuberculin	209	189	—285
Anti-Streptococcus Vaccine	500	500	500
Anti-Streptococcus Serum	1,339	1,117	1,339

Rinderpest.—During the year 1910-11, the output of Rinderpest Serum was 168,891 doses more than the previous year. The demand for this serum increases every year and is far greater than the output. It is interesting to note that its use is being appreciated in the Native States. The preparation of serum by means of Peritoneal Washings gave good results and effected a very considerable saving in the number of animals required.

As the result of a series of experiments carried out at Bareilly, the following important conclusions were arrived at:—

(1) The serum resulting from a single massive injection of virulent blood is superior in potency to that prepared by two successive injections of virulent blood.

(2) The serum resulting from a single massive injection of virulent blood, given at a negative phase, is superior to that prepared by a single massive injection at a positive phase.

(3) The serum from a massive injection of virulent blood diluted in an equal volume of Citrate of Potash Solution is superior to that prepared by a massive injection of defibrinated blood undiluted.

(4) A serum of very high potency can be prepared from Plains Buffaloes by a single massive injection of virulent blood obtained from buffalo controls.

(5) That the period allowed between the injection of virus and the bleeding for serum can, with benefit, be reduced from three to two weeks.

The practical application of these conclusions has so far given good results and it is hoped that the output of this serum can be very largely increased and the expense of preparation and the expenditure of susceptible animals materially decreased.

Anthrax.—A preliminary report on the result of experiments into the methods of Anti-Anthrax Serum and Vaccine preparation and their practical value has been completed.

Hæmorrhagic Septicæmia.—Further tests on the value of the Anti-Hæmorrhagic Septicæmia Serum and Vaccine in the protection of bulls, buffaloes and horses have been carried out, and a report on the subject has been submitted.

Surra.—The successful results of the treatment of this disease in horses have been published during the last year. Further reports on the subject are now ready.

Contagious Lymphangitis of Cattle.—Several specimens from cattle suffering from this disease have been submitted from Quetta. In sections, from the affected glands, club-shaped organisms have been repeatedly observed, similar to those described by me in I. C. V. D. Memoir No. 1.

A List of Papers published during the year 1910-11 bearing on Indian diseases.

Baldrey, F. S. H. Piroplasmosis in India. (*Journ. Trop. Vet. Science, v, No. 4.*)

" " A comparison of the different methods of preparing Hæmorrhagic Septicæmia Vaccine and the immunizing value of old and new vaccine of Hæmorrhagic Septicæmia. (*Journ. Trop. Vet. Science, v, No. 4.*)

Baldrey, F. S. H.	Transmission of Surra. (*Journ. Trop. Vet. Science, v, No. 4.*)
,, ,,	The preparation of Anti-Rinderpest Serum by other means than the injection of virulent blood. (*Journ. Trop. Vet. Science, vi, No. 1.*)
Balfour, A.	Further observations on Fowl Spirochætosis. (*Journ. Trop. Med. & Hyg., xii, No. 19, Oct. 1909.*)
Cinca, Al., & Stoicescu, G.	The Bacteriological Diagnosis of Charbon by cultures of the skin. (*Arhiva Veterinaria, vi.*)
Cross, H. E.	The preparation of Anti-Rinderpest Serum by the injection of virulent artificial peritoneal fluid. (*I. C. V. D. Memoir No. 3.*)
Darling, S. T.	Experimental Sarcosporidiosis in the Guinea-pig and its relation to a case of Sarcosporidiosis in Man. (*Journ. Experiment. Med., xii, No. 1, Jan. 1910.*)
Evans, G. H.	Elephant Surra, Trypanosomiasis in the Elephant. (*Journ. Trop. Vet. Science, v, No. 2.*)
Evans, G. H., & Rennie, T.	Notes on some Parasites in Burma—III. (*Journ. Trop. Vet. Science, v, No. 2.*)
,, ,,	Elephant Surra, Trypanosomiasis in the Elephant. (*Journ. Trop. Vet. Science, v, No. 4.*)
Gaiger, S. H.	Rabies. (*Journ. Trop. Vet. Science, v, No. 2.*)
,, ,,	*Filaria nudinasis* in the Dog. (*Journ. Trop. Vet. Science, v, No. 3.*)
,, ,,	Further observations on Trypanosomiasis, 1909-10. (*Journ. Trop. Vet. Science, vi, No. 1.*)
,, ,,	Pyelo-Nephritis in a Sheep. (*Journ. Trop. Vet. Science, vi, No. 1.*)
Hartley, P.	On the immunity to Hæmorrhagic Septicæmia of Bovines produced by the injection of sensitized vaccines. (*I. C. V. D. Memoir No. 3.*)
,, ,,	On the Immune bodies occurring in Rinderpest Anti-Serum. Part I—The precipitation of the Rinderpest Immune bodies by dialysis of the Immune serum. (*I. C. V. D. Memoir No. 3.*)

HARTLEY, P. . . Report on the preparation of the Rinderpest Anti-Serum by means of diluted virulent fluids. (*I. C. V. D. Memoir No. 3.*)

HOLMES, J. D. E. . The cure of Surra in horses by the administration of Arsenic. (*Parasitology, iii, No. 3, 22nd October 1910.*)

" " . The treatment of Surra in horses by means of Arsenic and its derivatives. (*I. C. V. D. Memoir No. 3.*)

" " . The cure of Surra in horses by the administration of Arsenic. (*I. C. V. D. Memoir No. 3.*)

" " . A further note on the cure of Surra in horses. (*I. C. V. D. Memoir No. 3.*)

" " . Some experiments in the treatment of Surra in camels. (*I. C. V. D. Memoir No. 3.*)

" " . Report to the Government of India on experiments carried out to test susceptibility of cattle for several districts and on improved methods of serum preparation. (*I. C. V. D. Memoir No. 3.*)

" " . The use of Anthrax Anti-Serum and Vaccines. Preliminary Report. (*I. C. V. D. Memoir No. 3.*)

" " . A note on elements resembling Spirochætes in the blood of man and animals. (*I. C. V. D. Memoir No. 3.*)

" " . Further testings of the Hæmorrhagic Septicæmia serum and vaccines on Bovines and Equines. (*I. C. V. D. Memoir No. 3.*)

JOWETT, W. . . Biliary Fever or Malignant Jaundice of the dog (Canine Piroplasmosis). The Drug Treatment. (*Agri. Journ., Cape of Good Hope, xxxv, 1909.*)

LESEK, A. S. . . Second series of experiments on treatment of Surra in Camels. (*Journ. Trop. Vet. Science, v, No. 3.*)

LEIPER, R. T. . Guinea-worm in domesticated animals, with a note of its discovery, by Mr. C. Grey, in a *Leopard*. (*Journ. Trop. Med. & Hyg., xiii, No. 5.*)

MITTER, S. N. .	A case of generalised Tuberculosis in a Macacus. (*Journ. Trop. Vet. Science, v, No. 2.*)
,, ,,	*Gnathostomum spinigerum* in a domestic cat. (*Journ. Trop. Vet. Science, v, No. 2.*)
,, ,,	Cutaneous Filariasis in a Dog. (*Journ. Trop. Vet. Science, v, No. 3.*)
NUTTALL, G. H. F. .	The drug treatment of Canine Piroplasmosis. (*Parasitology, ii, No. 4, 1909.*)
PLACE, F. E. . .	Kumree. (*Journ. Trop. Vet. Science, vi, No. 1.*)
RAYMOND, F. . .	Infectious Lymphangitis in Cattle. (*Journ. Trop. Vet. Science, v, No. 2.*)
,, ,,	Fowl Cholera (Pasteurellosis). (*Journ. Trop. Vet. Science, v, No. 3.*)
RUEDIGER, E. H. .	Observations on Cattle Plague in the Philippine Islands and the methods employed in combating it. (*Philip. Journ. Science, iv, No. 5, 1909.*)
,, ,,	Immunizing cattle against anti-cattle plague serum. (*Philip. Journ. Science, iv, No. 5, 1909.*)
SOWERBY, M. H. .	Some experiments in Trypanosomiasis; an endeavour to discover the reservoir of *Trypanosoma evansi*. (*Journ. Trop. Vet. Science, v, No. 4.*)
TREAT, B. T. . .	An attenuated Surra of Mauritius, with immunity tests after recovery. (*Journ. Exper. Medicine, xii, No. 2.*)

PROGRAMMES OF WORK FOR 1911-12

PROGRAMMES OF WORK OF THE VARIOUS SCIENTIFIC DEPARTMENTS FOR 1911-12.

1.—Combined Programme of the Director of the Imperial Institute, London, and of the Reporter on Economic Products to the Government of India.

1. **Turpentine.**—The determination of the hydrocarbons of Indian turpentine at present in hand at the Imperial Institute will be continued there.

2. **Fragrant gums.**—The examination and identification of the plants yielding the various trade forms of myrrh, frankincense, mastic, bysabol and other like products from the Gulf of Aden, Arabia and the Persian Gulf will be continued.

3. **Dyes.**—The investigation of the flower dyes named in "The Agricultural Ledger," No. 2 of 1908, in the hands of Professor A. G. Perkin, will be prosecuted. Minor investigations on the dyeing properties of *Baocaurea sapida* and *Symplocos spicata* will be carried on.

4. **Oils.**—The survey of Indian fixed oils by Mr. Hooper will be completed. Minor investigations on the oil of *Chrozophora verbascifolia* and *Amoora Rohituka* will be prosecuted.

5. **Oil-cakes.**—The Provincial Agricultural Departments and the Reporter on Economic Products are jointly preparing for a discussion of this subject at the next meeting of the Board of Agriculture.

6. **Citronella oil.**—If satisfactory determinations of the various oil grasses can be obtained the results of this enquiry will be published.

7. **Fibres and papers.**—Work on jute selection will be continued in conjunction with the Fibre Expert to the Government of Eastern Bengal and Assam; and the study of the microscopic structure of Indian paper stuffs will also be continued.

8. **Food grains.**—An attempt will be made to complete during the year the review of Indian races of juar (*Sorghum vulgare*).

9. **Dioscorea.**—The plates for the publication of the Monograph on Asiatic Dioscoreas are being prepared and the manuscript is being prepared for the press.

10. **Pulses.**—The investigations on the botany of Indian pulses will be continued.

11. **Caraway and allied condiments.**—The enquiry on the botany of these plants was transferred to the Royal Botanic Gardens, Kew,

where it is believed that Mr. J. R. Drummond has been entrusted with the work.

12. **Turmerics, Curcumas and other Scitamineæ.**—The enquiry will be continued: it is one which will take several years owing to the difficulty of obtaining good botanic specimens for identification. The object of the enquiry is to determine how far the roots of these plants yield starch and drugs.

13. **Gentians.**—The identification of gentians used as drugs is being prosecuted.

14. **Aconites.**—The investigation is to be continued on the same lines as before at the Imperial Institute.

15. **Hemp drugs.**—The study of the chemistry of Charas by Mr. C. R. Marshall of Dundee is in hand.

16. **Opium.**—Professor Dunstan promises the completion of his investigations on Indian opium.

17. **Solanaceous alkaloids.**—The examination of the alkaloids of *Datura Metel* and *Hyoscyamus niger* is in the hands of Professor Dunstan.

18. **Colchicum luteum.**—A toxicological and chemical examination of this plant is in progress in Cambridge.

19. **Peganum Harmala.**—A chemical study of the seeds is in progress by Professor J. F. Thorpe.

20. **Thalictrum foliolosum.**—Material for the study of this drug has been sent to Professor Dunstan. It is not quite certain if he proposes to continue work on it during the coming year or does not.

21. **Coptis Teeta.**—A chemical comparison will be made of the various forms of the drug.

22. **Saponin.**—Material for an extended study of this in plants continues to be supplied to Professor Schaer.

23. **Indigenous drugs.**—The Indigenous Drugs Committee is experimenting on the following drugs:—

1. *Melia Azadirachta.*
2. *Berberis Lycium.*
3. *Symplocos racemosa.*
4. *Rheum Emodi.*
5. *Ixora coccinea.*
6. *Holarrhena antidysenterica.*

24. **Poisons to stock.**—Attention during 1911-12 will be concentrated on this enquiry.

Enquiries in addition to the last Programme are—Coptis, Oil-cakes, and Opium.

Those in hand at the Imperial Institute are on—Turpentine, Aconites, Opium, Datura and Hyoscyamus, and possibly Thalictrum.

2.—Meteorological Department.

Meteorology.

1. **Daily weather work.**—In connection with the daily forecasting it is proposed to make a systematic study of some of the typical changes of weather of which the indications are at present but little known. Some recent work done upon the cold weather depressions of Northern India has brought to light important facts.

2. **Sounding balloons.**—Attempts have been made to carry on this work systematically by Indian assistants in the plains, the continued presence of an experienced officer being impossible with the present staff. The difficulties which are attendant on its technical and specialised nature indicated in the course of last year that success was very doubtful. The work is so important, however, that it was intended to make continued trials for at least a part of the present year. But it has now been found that successful operation cannot be secured without the personal supervision of an officer on the spot, and as the scientific staff of the department is under its authorised strength it has become necessary to stop the work entirely for the present.

3. **Atmospheric electricity.**—Owing to the absence on leave of Dr. G. C. Simpson, who joined the Antarctic Expedition for scientific purposes, it is not possible to continue, at present, the research work which has in his hands already led to the important results published in the Indian Meteorological Memoirs, Volume XX, Part 8, and the Transactions and Proceedings of the Royal Society.

Astronomy.

1. **Photographing the sun in ordinary light.**—This will be continued as in former years.

5. **Photographing the sun in monochromatic light.**—The routine work with the spectroheliograph will be continued and photographs in H α light will be taken with the new autocollimating spectroheliograph.

6. **Record of sunspots and of prominences.**—As before.

7. **Sunspot spectra.**—These will be studied visually with a much more powerful spectroscope than has been used hitherto.

8. **Variations in the solar constant.**—Photographic comparisons between first type stars and moonlight will be continued, and the plates already obtained will be measured and reduced. It is hoped that by this method it will be possible to detect variations from year to year exceeding ▮ per cent.

9. **Spectrum photographs.**—High dispersion spectra of sunspots will be obtained whenever possible for studies in radial and other movements in and near spots. In view of the approaching minimum of spot activity it is proposed to give more attention than hitherto to the movements in prominences, and comparison spectra of prominences and the centre of the sun's disc will be made when opportunities occur.

10. **Pyrheliometry.**—Absolute measurements of solar radiation by means of Angstrom's electric pyrheliometers have been made for some years in Simla, and it is intended to continue these. The instruments are liable to show change of constants, and, as there are no absolute means available in India for redetermining the constants, it has been arranged that one of the three instruments in Simla shall in the course of the year be restandardised in Upsala by the successor of the late Professor Angstrom.

Seismography.

11. As hitherto, there will be kept in commission the three Omori seismographs, two in Simla and one in Bombay. The smaller of the two Omori seismographs in Simla is now being replaced by a new machine, a duplicate in essential features of the larger machine in use.

The change will be advantageous in that the east-west and north south traces of the components of an earthquake will become strictly comparable.

The smaller seismograph is to be sent to the Rangoon Engineering College, where arrangements have been made to put it into use for the information of the Public Works Department of Burma on questions of building construction.

A vertical component seismograph of the Wiechert type has been obtained and is being erected in Simla. Its records, combined with those of the two present horizontal component machines, will afford fairly complete information of the ground movement.

Two Wiechert seismographs, of vertical and double horizontal-component types, are at present under test and adjustment in Simla, and are to be installed shortly at the Kolar gold fields by one of the local companies.

3.—Scientific Research Work of the Survey of India.

Gravimetric survey.—Pendulum operations in certain stations in Burma in the areas between Latitudes 12° and 25° and Longitudes 92° and 98° and at Port Blair and also observation of the proposed Moulmein-Bangkok arc of Longitude.

Latitude operations.—Latitudes will be observed in Burma.

Magnetic survey.—Colaba Observatory under the Meteorological Reporter, and the four observatories under the Surveyor-General of India, will continue to work. Observations will be taken at repeat stations and at certain selected old field stations and detailed surveys of disturbed areas will be continued.

Solar photography.—Photographs of the sun will be taken daily at Dehra Dun, as has been done since 1879 in conjunction with Greenwich.

4.—Geological Survey of India.

A.—Continuation of work already in hand.

(1) Revision of the survey of Central India and Rajputana
(2) Survey of the oil-bearing regions of Upper Burma.
(3) Survey of the Southern Shan States (interrupted since 1900).
(4) Survey of oil-bearing regions in Assam and the Punjab.
(5) Chemical investigation of salt and brine from Sambhar Lake.
(6) Examination of the salts of the Lonar Lake;
(7) Palæontological questions: description of—
  (*a*) Liassic fossils of Baluchistan;
  (*b*) Cretaceous and Tertiary fossils of Tibet;
  (*c*) Indian Tertiary molluscs;

(*d*) Jurassic Brachiopoda and Lower Palæozoic fossils from the Shan States;

(*e*) Silurian, Carboniferous and Triassic fossils of the Himalaya and Kashmir;

(*f*) Siwalik vertebrates;

(*g*) Fossil plants from Kashmir and Afghanistan.

B.—New subjects.

(8) Systematic survey of the Central Provinces.

(9) Investigation into the quantity and value of the potash salts in the Khewra mines.

(10) Boring for coal in the Dilwal plateau, Salt Range.

(11) Survey of the auriferous gravels of the chief Burmese rivers.

(12) Collection of Siwalik fossils in Sind and Kathiawar.

5.—Botanical Survey of India.

Work already in progress.—The Superintendent of the Royal Botanic Garden will continue his study of the plants of the Garden and publish a further instalment of the catalogue. The Curator of the Herbarium will elaborate the collections made by himself during 1910 in the south-east corner of Sikkim with a view to publication of the botanical results. He will also work up the collections made in Burma and Southern India during the current year by various officers of other Departments of Government. The Indian assistants for systematic work will aid both in the field and in the Herbarium.

New work.—As far as circumstances will permit the Superintendent will resume work that has been suspended for some time on the Burmese and Malayan species of the Natural Orders *Euphorbiaceæ* and *Urticaceæ*. A short account of the Malayan *Polygonaceæ* will, it is hoped, appear. The preparation for publication of the final instalment of Signor Beccari's great work on the *Lepidocaryeæ* palms will be undertaken; while the materials for the illustration of the Monograph on the genus *Dioscorea* by Colonel Prain and Mr. I. H. Burkill will be worked up.

Field work will, as circumstances dictate, be carried out by either the Director of the Botanical Survey or the Curator of the Calcutta Herbarium or one or other or both of the Indian assistants in a selected district in Eastern Bengal and Assam and in a selected district in the

Madras Presidency. It is not proposed to send any officer of the Survey to Burma as botanical collections in that province will be carried out by quite a number of officers belonging to other Departments of Government.

Work by associated officers.—The Director of the Botanical Survey has received no information as to any systematic work to be undertaken by either the Economic Botanist to the Government of the United Provinces or the Economic Botanist to the Government of Bombay. The Government Botanist, Madras, owing to pressure of work at the Agricultural College, sees no prospect of much touring during the coming year.

6.—Department of Agriculture.

Programme of the Agricultural Research Institute, Pusa.

The scientific work of the Institute for the coming year is indicated under the programmes of the different sections.

Students will be accepted for the post-graduate courses detailed in the prospectus. In addition to these, the short courses in cattle and poultry-breeding and management, fruit-growing, eri and mulberry silk-worm-rearing and silk-spinning, dyeing and weaving and lac cultivation, will be continued.

I.—Agricultural Chemistry.

1. The work on the availability of plant-food in soils will be continued, the immediate aim being the more correct ascertainment of the composition of the aqueous solution in the soil. Included in this section of investigation are naturally the amounts of nitrate in soils and soil-temperatures.

2. The investigation on soil-moisture and water-requirements of plants is being continued on lines which have been sufficiently indicated in the memoirs on the subject.

3. The investigation into the nature of certain *Usar* lands in the United Provinces is being continued.

4. An improved process for refining saltpetre has been devised and is now being tested.

5. The experimental error in sampling sugarcane will be tested.

6. **Education.**—This requires no special comment; it will be conducted according to the lines laid down.

7. The chemistry of the date-sugar industry is being enquired into by the Supernumerary Agricultural Chemist.

II.—Economic Botany.

1. **Training.**—The training of advanced students in this section will be continued.

2. **Plant breeding and plant improvement.**—During 1911, the following crops will be studied:—Wheat, tobacco, oil-seeds and fibre plants.

(*a*) **Wheat.**—The botanical survey of the wheats of Baluchistan and the agricultural survey of the wheats of Bengal will be completed. The production of improved and rust-resistant varieties by selection and hybridisation will be continued. The co-operative experiments on the influence of the environment on the milling and baking qualities of Indian wheats which are being conducted in collaboration with Mr. H. Martin Leake, Economic Botanist to the Government of the United Provinces, will be continued on an extended basis.

(*b*) **Tobacco.**—The production of new varieties by selection and hybridisation will be continued as well as the testing and curing of tht varieties already isolated. The investigations on the influence of the environment on the stability of the type and quality will be continued.

(*c*) **Oil-seeds.**—The study of the oil-seeds of India will be continued on similar lines to those adopted in the investigations on wheat.

(*d*) **Fibres.**—The isolation and testing of pure races of the fibre plants of India will be continued.

(*e*) **Fruit.**—The fruit experiments at Pusa will be continued on the lines laid down in the First Fruit Report. During the months, May to September, the work connected with the development of the fruit industry of Baluchistan will be commenced.

III.—Mycology.

1. **Research and experimental work.**—The work on the wilt diseases of crops will be continued on the lines indicated in the memoir on Pigeon Pea wilt published last year.

The investigation of fungus diseases of sugarcane will be continued. The chief points of the present enquiry are the spread of red-rot through the soil, the relative immunity of thin canes to this disease, and the study of two undescribed cane diseases.

The study of some fruit diseases commenced last year will be continued, particularly with reference to their control by spraying.

The Supernumerary Mycologist is engaged on an investigation of the root rot of a number of crops caused by the fungus *Rhizoctonia Solani*. This will be continued.

2. **Training.**—This will be continued on the lines indicated in the prospectus. Short courses will also be given to students taking the fruit-growing and general courses and to private students, as during the past year.

3. Advice regarding the fungus diseases of plants will continue to be given to other departments, particularly to the Provincial Departments of Agriculture and the Forest Department, and to the general public. The distribution of named specimens and other material to provincial colleges and other institutions will also be continued.

4. The collection and identification of Indian parasitic fungi will be continued. The Ascomycetes already collected having been worked through last year, it is proposed to take up the Deuteromycetes in which India is particularly rich.

IV.—Entomology.

1st Section.

Crop pests.—The study of the insect pests of crops will be continued in the insectary at Pusa and by the Assistants in the Provincial Agricultural Departments. A large amount of information relative to the life histories of many economically important insects has been gathered during the last few years, but for various reasons it has not been possible to publish these hitherto: an attempt will be made to complete these during the year 1911-12 and to publish them in a series of memoirs.

Termites.—The subject of termites (white ants) is engaging a considerable amount of attention. Methods of destroying them, in the case of those colonies whose nests can be located, are being tested in conjunction with the Deputy Director of Agriculture, Northern Circle, Central Provinces. A large series of experiments is also being conducted at Pusa with a view to the discovery of a really efficient preparation applicable to wood work as a preventive of their attack, and it is proposed to continue these experiments. The whole subject of damage done by Termites is a very important one in India and no opportunity will be lost of acquiring information on the subject.

Other insect pests.—Information will be collected on household pests, and insect pests of grain, fruit and gardens, and it is hoped to publish memoirs on these subjects.

Apiculture.—The subject of Apiculture has been engaging attention. Two strains of specially selected bees have been imported successfully and it is hoped that one or both of these may prove suited to the plains of India, where the ordinary European honey bee will not thrive in the hot weather. The experiments with these bees will be continued.

Lac.—Experiments with babul lac will be continued and seed will be cultivated, but it is not estimated that there will be any surplus seed available for distribution before June 1912.

In conjunction with the Forest Department, the collection of the monthly stages of the various races of the lac insect will be continued. The large amount of material already sent in, together with that to be collected during the current year, should provide ample data for precise discrimination of the distinctness or otherwise of the insects found on different food plants.

Silk.—The experiments with the hybrids already obtained between the Eri silk worm (*Attacus ricini*) and the wild form (*Attacus cynthia*) will be continued, as the hybrid forms promise to give good results from a disease-resisting point of view. Experiments will also be made having for their object the production of a mongrel race, between the European univoltine mulberry silk-worm and the Indian multivoltine form, combining the silk-producing qualities of the former with the many broodedness of the latter. A memoir has been prepared on the results arrived at up to the present in the study of Eri silk and it is proposed to publish this during the current year.

Insecticides.—New insecticides sent in for trial will be tested with a view to their introduction into India if found satisfactory as regards effi-

ciency and price. Particular attention will be paid to the various specifics against termites (white-ants).

Training.—Training of students taking the long course in general Entomology will be continued, besides the short courses in Sericulture. The usual practical training classes in lac culture will also be held in June and October.

Coloured plates, lantern slides, etc.—The preparation of coloured plates and lantern slides of economically important insects will be continued on the lines already laid down and the results rendered available for general use.

General work of the section.—The general work of the section (identification of specimens, preservation of the collections, replies to miscellaneous queries about injurious insects, etc.), will be continued. The amount of correspondence in this section is extremely large, and as the work of this department becomes more widely known, the preparation of replies to questions received takes a constantly increasing proportion of time which could otherwise be devoted to research work.

Every assistance will as hitherto be extended to the Agricultural Departments of the various provinces and of Mysore and Baroda. Due regard will be paid to any special line of investigation called for by the provinces, help will be rendered if required by a serious outbreak of any pests, and the work of the Entomological Assistants will be supervised, at least in the case of those provinces which desire this, in order that the general work on Agricultural Entomology in India may be co-ordinated and rendered as efficient as possible by the various workers being kept in touch with Pusa as a centre and thus with one another.

2nd Section.

Work on blood-sucking insects, ticks and other similar parasites injurious to man either directly or indirectly will be continued, special attention being paid to the insects capable of transmitting *Surra* and to the life histories and occurrence of mosquitoes and sand flies and the means of checking them.

Attention will also be given to the dipterous pests of crops and fruit, and to the application of practical measures to control or minimise their ravages.

During the absence of Mr. Howlett, a large mass of material for the study of biting flies has been received from various officers of the Medical

and Veterinary Departments. A large amount of time will have to be devoted to working through these and to the systematic arrangement of the collection of Diptera.

Instruction of agricultural students in a knowledge of pests of live-stock and poultry will be carried out.

V.—Agricultural Bacteriology.

1. The systematic investigation of the distribution, physiological characters and functions of soil bacteria in India will be continued.

2. A special line of enquiry will be taken up as to the relations existing between the practice of green manuring in India and the activities of soil bacteria.

3. Special problems, such as plant diseases of bacterial origin, will be dealt with as occasion may arise and opportunity permit.

4. The training of the assistants in the section will be continued.

VI.—Agriculture.

(A) Farm.

Permanent experiments.—The permanent manurial and rotation experiments will be continued.

The present scheme of pasture experiments will be abandoned. A modified scheme is under consideration.

(B) Cattle and Poultry-Breeding.

Cattle.—The object of the cattle-breeding operations at Pusa is to produce a superior type of milking cow for India, by selection methods. The type chosen is the Montgomery breed of the Punjab.

Sheep.—It is proposed to continue the crossing of Gorakhpur ewes with the Dumba ram during the coming year.

Poultry.—Work with poultry will mainly consist of—

(1) A continuation of the breeding work with such European breeds as have shown themselves suited to Indian conditions. Such are the various breeds of Wyandottes (except the Silver Laced variety), Orpingtons (except the Jubilee Orpingtons) and Barred Plymouth Rocks. Breeds, which

the experience of the last three years has shown to be absolutely unsuited to Indian conditions, such as Brown Leghorns and Single Combed Black Minorcas, will be eliminated during the year.

(2) It is proposed to introduce breeding pens of some of the best Indian breeds and to improve the type of these by careful selection. A beginning has already been recently made in this respect by the purchase of Bussorahs, Chittagongs and several types of Indian game.

The distribution of fowls and eggs to the Provincial Experimental Farms and to private individuals will be continued and the short course in practical poultry-keeping will be conducted as heretofore.

VII.—Imperial Cotton Specialist.

I.—To visit and advise on points regarding cotton and its cultivation whenever requested to do so by Provincial Departments of Agriculture.

II.—By special invitation of the Department of Agriculture, Punjab, to report on the work done in the way of cotton improvement in that province. The question of the distribution of seeds of improved varieties will be further discussed with the proper authorities in the Central Provinces and Bombay Presidency.

III.—The study of the behaviour of Bourbon, Buri and such other cottons in non-cotton producing tracts as detailed in my last year's programme will be continued.

IV.—The conditions of cotton cultivation in Kathiawar and adjacent parts will be investigated.

V.—An enquiry will be commenced on the manurial requirements of cotton.

VIII.—Provincial Departments of Agriculture.

The programmes for 1911-12 generally follow those approved by the Board of Agriculture held in February 1910. The following are, however, important additions:—

Bengal.—The Agricultural College at Sabour has been opened. Consequently much of the time of the Principal, the Agricultural Chemist and the Economic Botanist will be devoted to teaching work. Special attention will be given by the Professor of Agriculture to the trial of implements designed to save time in preparing the land and sowing

crops so as to enable a larger area of crops to be sown during the short period before and after the monsoon when they can be sown to best advantage. The activity of the Deputy Director of Agriculture will be chiefly directed towards training Superintendents for the management of large areas. He will also undertake the study of manurial residues in collaboration with the Agricultural Chemist. The cultivation of wheat is being undertaken for collaboration with the Imperial Economic Botanist in the survey of the wheats of the province. The use of cotton-cake as a manure and feeding stuff will be tested. At Chaibassa, endeavours will be made to find some convenient device to protect the silk-worms against inclemency of weather. As a result of a preliminary survey of field crops of the province, the Economic Botanist will now be able to undertake a detailed study of *Cucurbitaceæ*, *Leguminosæ*, *Setaria italica* and *Eleusine coracana*. He will also devote some attention to the collection of information regarding the crop pests of the province and to the plant-breeding work. The Agricultural Chemist will make observations in connection with the single plant selected leguminous crops in co-operation with the Economic Botanist, and will also study, if time permits, the effects of the nature of the soil upon an unidentified rice disease which is prevalent in Bengal.

United Provinces.—The Benares experimental farm will be fully equipped though it will not be possible to begin experiments during 1911-12. The Assistant Director of Agriculture will, along with other manurial experiments, take up the trial of cotton-cake manure on sugarcane at Partabgarh. Groundnut cultivation and hot weather tillage will also be undertaken. The growing of American cotton for seed supply and experiments with different methods of sowing which formed one of the items on the programme of 1909-10 will be abandoned. The Attara Agricultural Station will be equipped and tentative experiments will be started. The following new experiments will be started by the Deputy Director of the Western Circle:—

(1) Tillage experiments with wheat and maize;

(2) Variety tests with groundnut;

(3) Establishment of fuel and fodder reserves; and

(4) Testing of varieties of wheat and jowar.

Punjab.—At the new Agricultural Station of Gurdaspur, sugarcane will be chiefly dealt with. The Agricultural Chemist will undertake a survey of sugarcanes in that district. This work will consist of the analysis of canes at the time of crushing, the direct object being to secure

a record of the sugar-yielding capacity of the district for the purpose of establishing a co-operative sugar refining centre. Some preliminary experiments will also be made at Lyallpur to identify the principal features of the ripening process in cane and the effects of the application of water on this process. The Agricultural Chemist also proposes to investigate the nature of the silt deposited by the rivers Chenab and Jhelum which is reported in some cases to have checked or rendered germination difficult. Trials will be made by the Economic Botanist to determine whether jute can be profitably grown in the submontane or riverain tracts. The classified wheats of the Punjab which have been multiplied to a field scale will be tested in various parts of the province with a view to discover localities for which they are suited. The Assistant Professor of Mycology will undertake the investigation of fungoid diseases reported from districts or discovered during tours.

Bombay.—The Department of Agriculture, Bombay, does not propose to make any change for some years to come in the programme of work already undertaken. It will, however, take up in the near future the following three important lines of work:—

(*a*) To decide which of the exotic and hybridised cottons bred on the various farms offer the greatest profits in different localities and to confine the efforts to putting out the seed of the most promising variety in each case and establishing effective buying agencies for the produce.

(*b*) To study the question of providing the most suitable implements for the efficient cultivation of the various types of the black soil.

(*c*) To make a survey of the fodder supply in various localities and the best means of improving it.

Madras.—The extension of Cambodia cotton and the supply of green manure seeds, with a view to popularise the beneficial practice of green manuring wet lands, will receive increasing attention at the hands of the Department. Varieties of Cholam (*Andropogon Sorghum*), cultivated for grain and fodder in Coimbatore, will be tried direct on the black soil at Koilpatti. Some of the American varieties of Soy beans are being tried on this farm. Encouraged at the success of Cambodia cottons on irrigated lands, the Department has undertaken trials with exotic cottons including Sea Island, Bourbon and American Upland on the Palur farm. It is proposed to open a small factory at the Palur Agricultural Station for the supply of agricultural implements, the demand

for which is constantly increasing. The improvement of the dairy and the working herd, and the management, on commercial lines, of the dairy now under construction will be undertaken at the central farm at Coimbatore. The Agricultural Chemist proposes to give up the work on saline areas in the Periyar tract. The Economic Botanist will devote his attention to the flora of the country around Coimbatore. The Mycologist will investigate smuts of Cumbu (*Pennisetum typhoideum*) and Cholam (*Andropogon Sorghum*) and will continue the work on the Soft Rot of palmyra palms in the Godavari and Kistna Districts. The investigation into the application of the preventives to the Koleroga or Rot-disease of areca palm in South Canara will also be taken in hand.

Central Provinces.—A temporary demonstration experiment station will be started in the area commanded by the Ramtek tank and another on a large and permanent scale in the centre of the irrigable area in Chanda. Steps are being taken to transfer gradually to private enterprise the implement depôts opened at Government experimental farms. The farm at Damoh, which was temporarily started, will be abandoned as it has achieved its object, *viz.*, the demonstration of eradicating *Kans* by deep ploughing and flooding. Experiments will be made at Khandwa with a few varieties of cotton which give special promise. As the relative importance of the sugarcane crop has greatly increased on account of irrigation works, cultural experiments with this crop will be started this year at Raipur. As regards manurial experiments, steps will be taken to popularise the use of bone-meal among rice-growers and to manufacture the bone-meal so that it may be easily available to cultivators. The improvement of agricultural practice in irrigable areas to enable the people to avail themselves fully of the improved water-supply will be the most important feature of departmental work in future. There are at present 21 cotton seed farms and their number will be increased. In the *Kanthar* tract of Jubbulpore district, demonstration plots have been opened at various centres in Narsingpur, Jubbulpore, Seoni and Damoh with promise of success. An improved variety of Maghai *til* which is likely to do well in Narsingpur district is being introduced.

Burma.—No additions are proposed to be made to the programme submitted last year.

Eastern Bengal and Assam.—The principal crops dealt with by the Department are rice, jute, sugarcane, potatoes, tobacco and groundnut. Manurial experiments on rice land have been laid down to contrast the effects of green manure, cowdung, bone-meal and green manure with

lime. The Fibre Expert proposes to bring up to date the publication of the results of the joint investigation with the Reporter on Economic Products to the Government of India into the races of jute in Bengal. If possible, a short account will be published of some preliminary experiments in hybridisation with jute. Mr. Finlow will also publish a Monograph on Jute giving as complete a *resumé* as possible of general information on the subject as well as a summary of the results of experimental work up to date. The manurial requirements of flax are being investigated in collaboration with the Inspector General of Agriculture in India and an enquiry has been undertaken into the possibility of creating, if necessary, a cheaper system for the supply of flax seed from the cooler tracts of India. The various methods of planting sugarcane will be tested this year at Jorhat. As the soil of the Dacca farm has been found suitable for this crop, a larger area is being put down this year. Besides the local variety, several varieties imported from Jorhat will be tested on this farm. It is proposed to test the merits of summer-grown as against winter-grown potato seed on the Shillong farm. The two varieties of potatoes—Magnum bonum and King of Potatoes—which have proved best will be grown on a fairly large scale for distribution of seed. Successful results were obtained at Burirhat with the Sumatra cigar tobacco and the fire-cured cigarette tobacco last year. This line of work will be continued. It is also intended to experiment in producing cigarette tobacco from the local variety by fire-curing. Experiments with groundnuts will be continued at Jorhat as promising results have been obtained. The experimental cultivation of lemon grass will be discontinued as it has been found that the oil extracted does not pay in the province. Proposals are being submitted to the Local Government for the relinquishment of the Wahjain tropical plantation.

Efforts will be made by appointing special officers to bring home to cultivators, by means of demonstrations, such improvements in agricultural methods, as are suited to local conditions. With the object of improving the cattle of the plains districts a survey of the existing types of cattle and buffaloes and of the present sources of supply will be undertaken. In this enquiry, special attention will be paid to plough bullocks. The officer who will be entrusted with this work will be instructed to find out means that can be adopted to ensure a substantial and permanent improvement in the existing types. In the absence of recognised types the enquiring officer will endeavour to fix the ideal type by means of measurements of individual animals which are considered by intelligent raiyats to be the most efficient animals under local conditions.

7.—Forest Department.

Programme of work already carried out by the Sylviculturist during 1910-11.

Part I.

1. **The *sal* tree (Shorea robusta).**—During the year investigations were prosecuted in the Siwalik, Haldwani, Pilibhit, Gonda, and Gorakhpur Divisions of the United Provinces into (1) the effects on *sál* of drought, fire, frost and grazing, (2) the natural reproduction of this tree in forests of different types, and the steps necessary to aid it. Various experimental plots were laid out in connection with these enquiries.

Part II.

1. **The Uniform and Group systems of working forests.**—Investigations were carried out in the Siwalik, Haldwani and Naini Tal Divisions of the United Provinces into the question of the most suitable methods of working forests of *sál* and *Pinus longifolia* under the uniform system, or in certain cases under the group system.

2. **Exploitation of bamboos (Dendrocalamus strictus).**—Experiments in the Siwalik and Lansdowne Divisions of the United Provinces have been commenced in order to ascertain the best method of cutting and working bamboos with a view to obtaining the highest possible yield while maintaining a permanent and undiminished supply in future.

3. **Pollarding of trees for lac cultivation.**—Experiments were in progress in the Siwalik Division, United Provinces, to ascertain the most suitable methods of pollarding and working trees for the cultivation of lac.

4. **Statistical and miscellaneous sylvicultural information.**—The collection of such information has been in progress during the year in the United Provinces, where a number of sample and experimental plots were laid out and measurements taken in the Siwalik, Haldwani, Pilibhit, Gonda, Gorakhpur and Naini Tal Divisions.

Programme of work for the Sylviculturist for 1911-12.

Part I.

1. **The *sal* tree (Shorea robusta).**—Investigations will be continued, chiefly in the United Provinces, into the effects of drought, fire,

frost and grazing on *sál*, and on the conditions most suitable for reproducing this species naturally. Experimental plots will be laid out in various localities in this connection.

PART II.

1. **The Uniform and Group systems of working forests.**—Investigations will be continued, chiefly in the United Provinces, into the question of working forests of different types under the uniform and group systems, the chief species concerned for the present being *sál*, *Pinus longifolia*, deodar, and some other important hill species.

2. **Exploitation of bamboos (Dendrocalamus strictus).**—The experiments started in the Siwalik and Lansdowne Divisions of the United Provinces in 1910-11, to ascertain the best method of cutting and working bamboos, will be continued.

3. **Pollarding of trees for lac cultivation.**—The experiments in the Siwalik Division, United Provinces, to ascertain the most suitable methods of pollarding and working trees for the cultivation of lac, will be continued.

4. **Statistical and miscellaneous sylvicultural information.**—The establishment of sample and experimental plots, for the collection of statistical and sylvicultural information regarding the more important species of trees, will be continued, chiefly in the United Provinces.

Programme of work already carried out by the Forest Botanist during 1910-11.

PART I.

1. **Physiology and ecology of *sal*.**—The experiments carried out during 1909-10 and 1910-11 on the dying back of the seedlings of *sál* and its causes have given interesting results which are now being prepared for publication.

2. **Forest grasses.**—The Botanist was able to study the types of *Saccharum arundinaceum*, *S. Munja*, *S. prophyrocomum* and *Erianthus Griffithii* at the British Museum and Kew during the year with interesting taxonomic results. The results of this work and of the previous field study of these and six other species are now in the press. The detailed study of Bhabar, *Ischæmum angustifolium*, has been commenced.

PART II.

1. **Physiology and ecology of teak.**—The work on teak on the same lines as for *sál* is not yet sufficiently complete for publication.

2. **Fungoid diseases.**—The field study of *Trametes pini* on the Blue Pine has been commenced in the Simla and Bashahr Divisions of the Punjab.

ADDITIONAL OUTSIDE PARTS I AND II.

1. **Systematic Botany.**—The Botanist was able to study the types of *Grewia* sp. at the British Museum, Kew and Paris, during the year and the results are being prepared for publication. The study of *Xylia* and *Anogeissus* has been commenced.

Programme of work for Forest Botanist for 1911-12.

PART I.

1. **Physiology and ecology of *sal*.**—The study of the *sál* will be continued with special reference to the diseases of these trees, the conditions favourable and unfavourable to successful germination and early development, the dying back of seedlings and its causes, the pollination of the flowers and distribution of seeds, the effect of coppicing on the development of the plant.

2. **Forest grasses.**—The study of grasses commonly found over large areas in *sál* forests will be continued chiefly with the object of discovering the best method of treatment for (*a*) increasing the value of these grasslands for fodder or other economic purposes and (*b*) afforesting these grasslands with *sál* (or other valuable tree-species), respectively.

PART II.

1. **Fungoid diseases.**—The study of *Trametes pini* on the Blue Pine will be continued.

2. The study of teak on the same lines as for *sál* will be continued.

ADDITIONAL OUTSIDE PARTS I AND II.

Systematic Botany.—A detailed systematic study and description will be made of forest plants of economic value in cases where the existing classification is unsatisfactory. A study of the following genera is now in hand: *Grewia*, *Xylia* and *Anogeissus*.

Programme of work already carried out by the Forest Economist during 1910-11.

Part I.

Investigation into the economic aspect of the sál tree (Shorea robusta).

1. **Technical properties.**—A number of tests have been carried out and others are in progress and timber of various kinds is being seasoned for the preparation of scantlings which will be used for shearing, bending and crushing tests.

2. **Antiseptics.**—Numerous experiments are in progress to determine how *sál* wood may best be antiseptically treated.

3. **Supply and markets.**—Much information has been collected and more will be obtained.

Part II.

1. **Paper pulp.**—Many forests were visited and a lengthy note has been written on bamboo, but it cannot be completed until a final report is received from the mill which has undertaken an exhaustive test. In the same report the financial aspect of the work and the question of suitable sites for factories has also been discussed.

2. **Match manufacture in India.**—Several forests in the United Provinces were visited and information collected.

3. **Antiseptic treatment of woods.**—A note on the subject has been sent to press and the experiments are being continued. Arrangements have been made for the powellizing of 5,000 sleepers, of woods that are not durable in their natural state, so that they may be tested by the railway companies. Six hundred and fifty of these sleepers have been treated and sent to the railway companies, the delay in the despatch of the balance is not due to the want of effort on the part of the Research Institute.

4. **Enquiry regarding the possibility of putting certain gums, resins and oleo-resins on the European markets.**—A number of samples have been sent and reports received and enquiries are still being received and information and samples being collected and supplied.

5. **Paving blocks.**—Samples of wood were sent to Japan but no report has yet been received.

6. **Wood for pencils.**—Samples and information have been supplied to firms and a note will be issued shortly.

7. **Wood for other purposes.**—Samples have been supplied, information collected and tests made in some cases with wood for brushes, cricket bats, mathematical instruments, tool handles, weaving looms, umbrella handles and other minor industries.

8. **Description of woods at present little known.**—The information has all been collected for six species and will be published shortly.

9. **Andamans Padauk.**—The question of the disposal of this timber is under investigation.

10. **Miscellaneous.**—Terminalia and oak barks have been tested for tannin, the seeds of *Schleichera trijuga* for oil, the flower of *Strobilanthes* sp. for perfume for soap; information has been supplied to an English firm about Indian walnut burrs, *Cinnamomum glanduliferum* is being tested for Camphor and the roots of *Podophyllum Emodi* are being analysed.

Programme of work for the Forest Economist for 1911-12.

Part I.

Investigation into the economic aspect of the sál tree (Shorea robusta).

The following investigations, some of which are already in hand, will be undertaken or continued:—

1. Physical properties of *sál* timber: strength under shearing, crushing and bending tests of timber grown in different localities, felled at different seasons and seasoned in different ways: tests of flexibility of the same: best methods of seasoning the same: determination of the specific gravity and of the durability of the same.
2. The effects of different antiseptics on *sál* timber.
3. Uses to which the timber and minor products of *sál* can be put, tanning value of bark, etc.
4. Calorific value of *sál* fuel and charcoal.
5. Collection of information regarding markets for *sál*, past and present prices, available supply, etc.

PART II.

It is proposed—

1. To collect and supply information of all kinds regarding the use of bamboos, wood, and grasses for paper pulp.
2. To collect and supply information of all kinds regarding the development of the match industry in India, which is now assuming a promising aspect.
3. To carry out experiments on woods with various antiseptic preparations, and specially to treat a large number of railway sleepers of inferior woods and have them tested by the railway companies with a view to encouraging their use.
4. To investigate the physical properties and seasoning powers of certain woods.
5. To investigate the properties of certain gums, resins and oil seeds, and tan barks, and to extend their use.
6. To investigate the value of certain Indian woods for packing cases, tea and opium boxes, paving blocks and other minor purposes.
7. To publish full information about certain useful woods at present little known.
8. To investigate the resin tapping of conifers and the possibility of improving the present method of distillation.
9. To investigate the uses of certain fibres.

Programme of work already carried out by the Forest Zoologist during 1910-11.

PART I.

1. ***Sal* insect pests.**—This study was continued during the year but the results are not sufficiently complete for publication.

PART II.

1. **Lac.**—Study was confined during the year chiefly to the insects, parasitic or otherwise, which were bred out of the lac samples collected in different localities. The results are not sufficiently complete for publication.

2. **Reference collection.**—All named specimens were arranged in order under their families and a card index catalogue was commenced.

Specimens which could not be named in India have been sent to European experts for identification.

Programme of work for Forest Zoologist for 1911-12.

Part I.

1. **Sal insect pests.**—The study of insects beneficial or injurious to the *sál* will be continued.

Part II.

1. **Lac.**—The detailed study of the lac insect will be continued in co-operation with the Agricultural Research Institute at Pusa.

2. **Reference collection.**—The work of extending the reference collection of insects which are important from a Forest point of view will be continued.

Programme of work already carried out by the Forest Chemist during 1910-11.

Part I.

1. ***Sal* bark tannin extract.**—The investigation is completed. The report is under preparation.

Part II.

1. **Russa grass oil.**—The investigation is in progress and the oils have been prepared in quantity.

2. **Oil seeds.**—Hydraulic Oil Press has been received. The investigation has been begun.

3. **Oil grasses.**—The distillation of Khas grass is in hand.

4. **Milk of Dichopsis elliptica.**—No progress has yet been made as the milk could not be obtained.

5. **Resin.**—Samples of resin tapped from *Pinus Merkusii* and *Pinus Khasya* are being collected.

6. **Myrobalans.**—The investigation is completed. Final report is under preparation.

7. **Decolourisation of tannin extracts.**—The results of the commercial value of the Mangrove tannin extract, made at Rangoon, are being awaited.

Programme of work for Forest Chemist for 1911-12.

PART II.

1. **Russa grass oil.**—It is desirable to study the causes of differences between the two varieties Moti and Sophia, and the possibility of the conversion of the Sophia into Motia oil. The oils have been prepared in quantity and will be separated into their constituent parts later on.

2. **Oil seeds.**—Oil-yielding forest seeds will be examined as to their oil value and their constituents.

3. **Oil grasses.**—The Khas oil will be studied.

4. **Milk of Dichopsis elliptica.**—The milk of *Dichopsis elliptica* will be studied for its commercial utilisation.

5. **Resin.**—The study of the resins of the principal conifers in connection with the manufacture of turpentine will be continued.

6. **Myrobalans.**—Investigation regarding the best season for the collection of Myrobalans so as to obtain the greatest yield of tannin will be continued.

7. **Decolourisation of tannin extracts.**—The enquiry as to the decolourisation of dark-coloured tannin bark will be continued.

8. Zoological and Anthropological Section, Indian Museum.

The Superintendent will continue his investigations on the fauna of stagnant water.

The Assistant Superintendent in charge of Crustacea and other marine invertebrates will conclude his systematic account of the Indo-Pacific Stomatopods and will begin to investigate the freshwater prawns of India.

The Assistant Superintendent in charge of fishes will continue his work on the freshwater fishes of India and the neighbouring countries, especially those known to be destructive to mosquito larvæ, and will work out the *Carangidæ* taken by the trawler "Golden Crown."

The Assistant Superintendent in charge of Entomology will continue his investigations into the biology and taxonomy of the Oriental Pedipalpi and will, with the assistance of Mr. C. A. Paiva, arrange the data obtained in a year's "census" of the mosquitoes of Calcutta.

The Surgeon-Naturalists of the Indian Marine Survey will probably work in the Museum on the marine Entomostraca of the Burmese coast.

9. Civil Veterinary Department.

By the Imperial Bacteriologist.

1. **Anthrax.**—To continue the investigations laid down in the programme of the previous year.

2. **Surra.**—To continue experiments in methods of treatment and prophylaxis.

3. **Rinderpest.**—Investigations as to possibility of preparing serum for buffaloes; and also the use of other than hill bulls for the preparation of serum for bovines.

4. Further tests of serums and vaccines prepared during the past three years.

By the officer investigating camel diseases.

(1) Investigations into Surra in the field.

(2) The study of Filariasis in the Camel.

(3) Treatment of Surra in the Camel.

By the Provincial Staff—Punjab Veterinary College Laboratory.

(1) Treatment of Surra.

(2) Study of Hæmorrhagic Septicæmia.

By Provincial Superintendents.

Collection of information and the mapping out, as opportunity occurs, of the incidence of Surra, Piroplasmosis, Hæmorrhagic Septicæmia and Anthrax.

APPENDIX.

APPENDIX.

REPORT ON THE SCIENTIFIC AND TECHNICAL INVESTIGATIONS CONDUCTED FOR INDIA AT THE IMPERIAL INSTITUTE DURING THE YEAR ENDED 30th SEPTEMBER 1911.

BY

W. R. DUNSTAN, M.A., LL.D., F.R.S.

The scientific and technical investigations which have been in progress at the Imperial Institute for India during the year ended the 30th September 1911 are as follows:—

1. **Opium.**—The examination of the constituents of a large number of specimens of opium, collected in various districts of India at the instance of the Government, was completed, and a report is now in preparation. Further recommendations were made during the year for the improvement of the process employed at Ghazipur for the preparation of opium alkaloids.

2. **Solanaceous plants.**—The investigation of Indian Solanaceous plants was continued, and reports were furnished on the alkaloids present in the seeds and capsules of *Datura Metel* and in the leaves and seeds of *Hyoscyamus niger*. These reports concluded the examination of the specimens of Solanaceous plants forwarded to the Imperial Institute from India.

3. **Tobacco.**—Further samples of tobacco grown at the Government Farm, Burirhat (Rangpur district), were received for examination in continuation of the previous investigation. The composition of the tobacco was determined and expert opinions were obtained regarding the quality and commercial value of the specimens. Recommendations were made in the report for the improvement of the tobacco.

4. **Tanning extracts.**—Twelve tanning extracts prepared at the Government Factory, Rangoon, were submitted for examination in continuation of a previous investigation upon which three reports had been furnished. The twelve samples included eight mangrove extracts, certain of which were of promising quality and were richer in tannin than any tanning extracts previously received at the Imperial Institute from India. In order to sell readily in the United Kingdom, however, the extracts should contain less moisture and be of better colour than the samples examined.

At the request of the Imperial Forest Chemist, a sample of mangrove extract, specially prepared at the Government Factory at Rangoon, was examined. It proved to be of superior quality, and a larger sample was asked for in order that practical tanning trials on a commercial scale could be made to determine its market value.

5. **Lemon grass oil.**—A small consignment of oil distilled from four varieties of lemon grass grown at Wahjain in the Khasia Hills was forwarded for examination and sale on the London market. All the oils contained a satisfactory amount of citral and that distilled from "Cochin" grass was particularly rich in this constituent. The latter oil was sold at 3½*d.* per oz. and the remainder of the consignment at 2¾*d.* per oz.

6. **Rubber.**—The rubber of *Cryptostegia grandiflora* from the Punjab was examined, and valued at 2*s.* 9*d.* to 3*s.* per lb. with fine hard Para at 5*s.* 2½*d.* per lb. Another sample of this rubber furnished to the Imperial Institute by H. H. the Maharajah Sindhia of Gwalior, was of very fair quality and was valued at 3*s.* 4*d.* to 3*s.* 6*d.* per lb. with fine hard Para at 4*s.* 8*d.* per lb. The rubber of *Cryptostegia grandiflora* would be readily saleable in London, but the small yield obtained on tapping the stems has hitherto prevented its collection on a commercial scale.

7. **Drugs.**—Cultivated rhizomes of *Podophyllum Emodi*, forwarded by the Forest Department of the North-West Frontier Province, were examined. The preliminary results showed that the cultivated rhizomes closely resembled in composition the rhizomes of the wild plant as previously examined at the Imperial Institute, and would probably be as suitable for use in medicine. A further supply was requested in order that therapeutical trials might be made with 'podophyllin' prepared from the cultivated rhizomes.

8. **Turpentine.**—Reports were furnished during the year to the Inspector General of Forests on samples of colophony and turpentine oil prepared at Naini Tal. The colophony was of much better quality than a sample from Naini Tal previously examined at the Imperial Institute, and similar material would sell readily in the United Kingdom at good prices. The turpentine oil would find a market as a substitute for Russian oil.

9. **Black dammar resin.**—In continuation of a previous investigation, samples of black dammar resin prepared by the Imperial Forest Economist were examined in order to determine the suitability of the resin as a substitute for shellac in finishing crape. Technical trials

showed that the resin alone was not very suitable for the purpose, but that when mixed with 8 per cent. of beeswax it might find a restricted application in crape manufacture. The principal incentive to the discovery of a substitute for shellac disappeared however when the price of shellac resumed a normal level in 1910.

10. Investigations were made to determine the suitability for paper-making of jute stems from which the bast fibre had been stripped. It was found that the pulp was composed of very short fibres and consequently would be of little value.

11. **Cotton and silk.**—Samples of cotton from the United Provinces, the Central Provinces, Sind and Burma were examined and reported on during the year. Two samples of mulberry silk from Eastern Bengal and Assam were of promising quality and were valued at 11*s.* and 8*s.* per lb., respectively. A sample of silk from Mysore was of very satisfactory quality and was valued at 13*s.* 6*d.* per lb. in the United Kingdom.

12. Seven samples of asphalt from the island of Bahrein in the Persian Gulf were examined. The best of these contained about 20 per cent. of bitumen in a limestone matrix, and was quite similar to Bahrein asphalt examined at the Imperial Institute in 1903. As a whole the samples represented material which could be used to produce a standard paving asphalt.

The facilities offered by the Imperial Institute for obtaining information respecting the value of Indian products are becoming more widely utilised by the Government officials and merchants in India, as well as by firms in the United Kingdom interested in Indian products, and in addition to the abovementioned investigations, a large number of other products from India were examined and reported on during the period under review. Information has been supplied on such matters as the manufacture of chromates from chrome ore, the manufacture of wood pulp, the manufacture of animal charcoal, the curing and preparation of porpoise hides, the curing of ratskins, the cultivation of vetiver, and the preparation of loofahs; and also regarding the market in Europe for various Indian drugs and for squirrel skins, goat hair, fowls' feathers, etc.

Information was furnished during the year to the Government of Mysore on the subject of the markets for sandalwood in Europe and the United States, and also regarding the exportation of Mysore timbers to Europe.

INDEX.

C

D

E

F

N

O

P

R

S

T

Departmental Publications.

I.—Meteorological Department.

Government of India Office.

(1) The India Daily Weather Report and Chart.
(2) The Weekly Rainfall Summary.
(3) The Monthly Weather Review.
(4) The Annual Summary.
(5) The Rainfall of India.
(6) Indian Meteorological Memoirs.

Bengal Office.

(1) Bengal Daily Weather Report and Chart.
(2) Monthly Rainfall Tables and Summaries of the chief features of the weather of the month over Bengal.

Bombay Office.

(1) Bombay Daily Weather Report and Chart.
(2) Monthly Abstracts of the Bombay observations (*Bombay Gazette*).

Madras Office.

(1) Bombay Daily Weather Report and Chart.
(2) Monthly Rainfall Tables (*Madras Gazette*).

Allahabad Office.

(1) Monthly Weather Summaries (*United Provinces Gazette*).
(2) Annual Summary.
(3) Monthly Rainfall Tables (*United Provinces Gazette*).

Lahore (Simla) Office.

(1) Monthly Summary
(2) Annual Summary
} of Punjab weather.

II.—Geological Survey.

The publications of the Department include—

Palæontologia Indica arranged in series, and sold in parts which are priced at 4 annas (6 pence) per plate.

Memoirs, Vols. I—XXXVIII, including the larger papers on geological subjects.

Records, Vol. I—XL, including the shorter papers and Annual Reports from 1866 to 1910, sold in parts, price one rupee each.

Manuals, Guides and Maps.

A complete list of the contents of these publications can be obtained by application to the Registrar, Geological Survey of India, 27, Chowringhee Road, Calcutta.

Indexes to the Genera and Species described in the *Palæontologia Indica* up to 1891, to the Memoirs, Vols. I—XX, and to the Records, Vols. I—XXX, have been printed for sale.

III.—Survey of India.

(1) Annual General Report.

(2) Professional Papers.

IV.—Botanical Survey and Royal Botanic Garden, Calcutta.

(1) Annual Report of the Botanical Survey of India.

(2) Records of the Botanical Survey, Vols. I—III, Vol. IV, Nos. 1—4, and Vol. V, No. 1.

(3) The Agricultural Ledger.—A series of papers on economic products issued as ready.

(4) Commercial circulars printed for circulation but not for sale.

(5) Annual Report of the Industrial Section, Indian Museum.

(6) Annual Report of the Royal Botanic Garden, Calcutta.

(7) Annals of the Royal Botanic Garden, Calcutta, Vols. I—XII.

A list of the contents of the Records and of the Annals with prices of the numbers and volumes still available can be obtained by applying to the Superintendent, Royal Botanic Garden, Calcutta.

V.—Department of Agriculture.

(1) Annual Report.—An account of the year's work of the Imperial Department, including the separate reports of the scientific officers of each branch (Agricultural Chemistry, Botany, Mycology, Entomology, and the like).

(2) The Agricultural Journal of India.—A quarterly journal containing articles on agricultural matters intended for the educated agriculturist and the general reader interested in Agriculture.

(3) Scientific Memoirs of the Department of Agriculture.—An occasional publication for papers of a scientific or technical nature divided into series such as Chemical, Botanical, Entomological, and the like.

(4) Bulletin.—An occasional publication containing information on agricultural matters of a temporary nature.

(5) Leaflets.—Short notes of practical instruction in agricultural matters, dealing mainly with entomological subjects.

VI.—Forest Department.

(1) Review of Forest Administration in British India by the Inspector-General of Forests (issued annually).

(2) Annual Progress Report of Forest Administration in each Province.—Issued by the Local Governments annually.

(3) Indian Forest Records.

(4) Indian Forest Memoirs.

(5) The Indian Forester.—A monthly Journal of Forestry, Agriculture, Shikar and Travel. This is a Departmental Journal, published monthly.

(6) Bulletins are published from time to time.

VII.—Zoological Department.

(1) The Annual Report, 8vo.

(2) The Records of the Indian Museum, 8vo. Containing short papers on Indian zoology. One or two volumes issued annually in quarterly parts.

(3) The Memoirs of the Indian Museum, 4to. Containing monographs and other important papers. Published at irregular intervals.

(4) Descriptive Catalogue of Indian Decapod Crustacea, 4to. Parts published at irregular intervals.

(5) Descriptive Catalogue of Indian Echinodermata, 4to. Parts published at irregular intervals.

VIII.—Civil Veterinary Department.

(1) Annual Report.

CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
8, HASTINGS STREET